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Tail Spins and Forced Landings

By Lt. Barrett Studley, U. S. N.

Passenger Routes Over the North Pole

By Lt. John T. Rowland, U. S. N. R. F.

XUM

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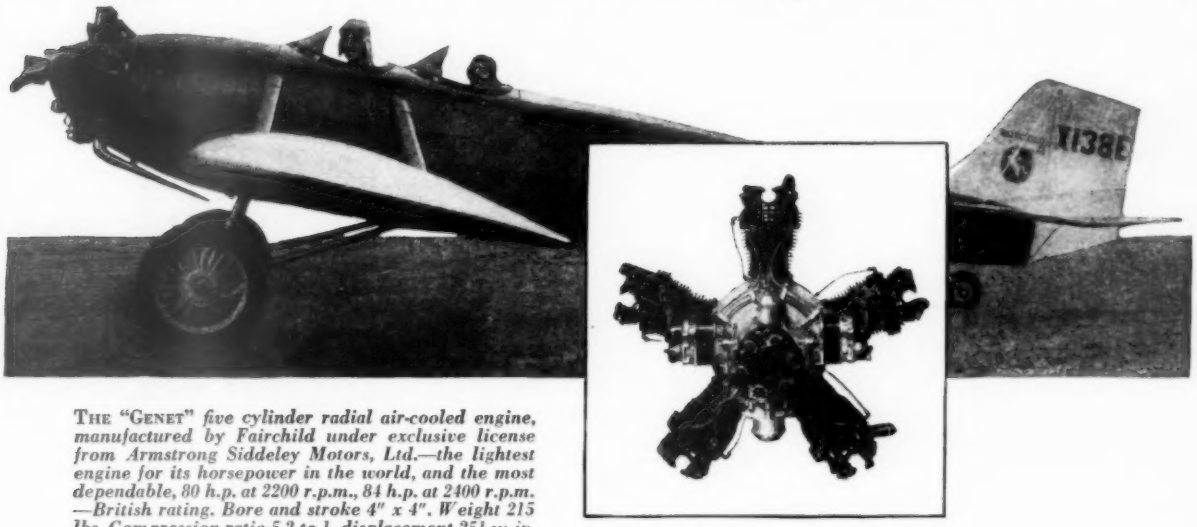

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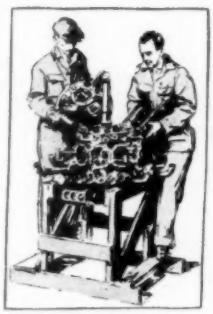

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(Signed) E. J. Demas.

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Hon. Robert Patterson Lamont

The post of Secretary of Commerce, held with such a conspicuous record of service by President Hoover, has been given to Robert Patterson Lamont, who will have under his charge the important Bureau of Aeronautics.

Mr. Lamont was 61 years old last December. He was born in Detroit and began his professional and business career as an engineer at the Chicago exposition of 1891-92. He served for seven years as first vice president of American Steel Foundries before becoming its president in 1912. He is a director in banking, manufacturing and commercial enterprises. He was chief of the Procurement Division of the Army Ordnance Department with the rank of Colonel in the World War. As a member of a committee of the International Chamber of Commerce he went to Europe to study trade relations with the United States. As an engineer he has served on committees having to do with the great Missouri flood of 1927 and the Illinois River drainage system.

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A former student,
(Signed) LOGAN M. KELLY, Jr.

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Aviation Schools

FORTUNATELY for everyone concerned the age of buncombe is passing, as far as it concerns aviation schools. With a little more help from earnest magazines, some strict admonition from Uncle Sam, the youth of the country will no longer be the prey of unscrupulous promoters of aviation schools of the "Daring Young Men" type.

It is amazing with what rapidity the men who are the logical prospects of these schools have become expert in sifting the claims that are made by the school racketeers. Extravagant statements as to earning possibilities, confident promises of glorious futures, full of thrills and adventures, are now leaving these young men rather cold.

Education has led them to ask embarrassing questions of the promoters. They are no longer to be hypnotised into signing on the dotted line and making a down payment by the specious claims of the old "mail-order" type. They want to know about equipment, about the instructors, and about the actual flying time and the ground school instruction.

There are fine aviation schools in this country; schools where men can be taught to fly, safely and thoroughly. These schools are not to be judged by size, but by the personnel of the staff and the equipment. No school can be condemned on the score of smallness. It is the calibre of the men in charge, the aptitude and experience of the instructors, and the condition of the equipment that furnishes the gauge by which a school can be measured.

If for no other reason than the selfish one of saving ourselves the trouble of answering hundreds of letters, let us offer these earnest young men who wish to learn to fly a few words of advice about the choice of a flying school.

First, a complete physical examination should be offered, and taken, before actual enrollment and the payment of fees. No man wants to be told, and no reputable school wants to tell him, when half through a course, that he can never pass the complete physical examination.

Second, the flight instructors should have transport licenses. The license is no proof of capability for instruction, but it offers some assurance to the student that the men who are to teach him have had the requisite number of hours in the air, and are, at the least, experienced.

Third, flying equipment should be licensed. There can be little argument on this score. Poor equipment means dangerous instruction.

Fourth, every school worthy the name has a rigid inspection system for its flying equipment. New, licensed ships that are flown by students and subjected to the strains of instruction work must be inspected carefully and often.

Lastly: the school must offer the student a course that will qualify him for a license.

These requirements are so simple and elemental that to state them might seem absurd if it were not for the fact that there are many so-called schools that cannot meet them. It should be obvious to the prospective student that he is wasting his time, and possibly endangering his person to accept less than these minimum requirements.

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BARLING NB3 Monoplane

Tail Spins and Forced Landings

By Lieutenant Barrett Studley, U. S. N.

TAIL spins and forced landings are the most prolific sources of aviation accidents. Every so often there is a headline in the papers, "Killed in crash as motor fails." The account ordinarily states that, after stopping of the engine, the plane went into a spin at a low altitude and failed to recover. Or perhaps it was simply cruising along in apparently normal flight when, for no known reason, it plunged earthward. In any case it is depicted as falling helplessly. The crash will very likely be reported as having occurred "in spite of the pilot's efforts to regain control." One article in a recent issue of a popular magazine even referred to "the deadly tail spin dreaded by all aviators."

In the minds of those not familiar with aviation, there has thus been built up an unfortunate impression. By many it is believed that there is something mysterious and deadly about a tail spin. It is supposed to lie in wait ready to spring unexpectedly on even the most skillful pilot. Once in its grasp he is impotent, dragged inexorably down to destruction. Engine failure is likewise thought of as fraught with imminent peril. Undoubtedly there are some who believe that an airplane with a dead engine falls like a rock. And probably many more assume that a forced landing must be more or less of a gamble with death. It may turn out all right, but the chances are against it.

As a matter of actual fact, the two following statements can be made without hesitation or equivocation:

First, it is impossible for any competent and alert pilot flying a standard plane to get into a tail spin accidentally out of any normal maneuver.

Second, after engine failure on any ordinary flight a safe landing can always be made by the exercise of average care and skill.

These statements are undoubtedly contrary to the ideas of the majority of people. Perhaps some pilots will consider them rather sweeping. But they are not made haphazardly. The actual experience of modern aviation warrants them. Consequently there is no escape from the conclusion that a considerable percentage of aviation accidents are really and readily avoidable.

A plane is sustained by the lift on its wings as they move through the air. In order to get enough lift, it must move at high speed. If its speed falls below a certain critical point, varying with type and load, the plane will "stall" or go out of control. Unless more speed is immediately gained, it will then spin. In a spin, it falls vertically toward the earth, whipping around in rapid rotation with its nose down at a steep angle.

That, in brief, is the explanation of a spin. Obviously there is nothing in the least mysterious about it. If a plane has flying speed, it cannot spin. If it loses its speed, it will spin. That is all there is to it.

There are only two ways in which flying speed can be lost—by holding the nose too high or by skidding. A plane will not climb straight up like an elevator. It must go up a grade and, as in the case of an automobile, the grade it will climb is limited. If you try to make it climb too steeply, it will stall. (It must be remembered that the term

"stall" in aviation refers to the speed of the plane, not of the engine. The latter may be running at full speed throughout a stall.) The same thing happens when the nose is not depressed sufficiently in a glide. With the motor throttled down, the plane is in effect coasting down hill. If the pilot does not make the hill steep enough, naturally it will slow down.

The other way in which a plane can stall is by skidding. Just as in the case of a motorcycle going around a corner, the rate at which a plane will turn depends on how far it is tilted sidewise or banked. If the pilot applies too much rudder for the amount of bank, instead of turning the plane more rapidly he will simply swerve its nose inward. It will then crab through the air slightly sidewise to its line of motion. The increased wind resistance will at once slow it down. If the skid is marked a stall will result.

A plane cannot spin with its control stick in neutral or forward of that point. If, when a plane stalls, the stick is merely pushed forward to neutral, it will go into a moderate straight dive. In this it will at once regain flying speed and the nose can be lifted with the elevators. But if the stick is held back of neutral in a stall, the raised elevators will prevent the regaining of flying speed. The plane will then spin. But any properly designed plane can continue to spin only so long as its elevators remain in this position. As soon as the stick is returned to neutral, the spin will be immediately stopped. A moderate dive will ensue in which flying speed is promptly picked up. The explanation seems simple enough. And the practice in reality is not much more difficult.

But, since we read about them, accidental tail spins must happen. One day at the Naval Air Station at Pensacola a student was practising stunts. He was having some difficulty, and lost control a number of times. Finally he went into a spin at about 2,000 feet altitude. This he stopped promptly, but almost immediately he started spinning in the opposite direction. Again he almost recovered only to whip off once more. A third time he almost regained control, but just failed to do so. The fourth attempt might have been successful had not the downward progress of the plane been abruptly terminated by a large and uncompromising roof. From this he was presently helped down, shaken up but unhurt. The plane came down in pieces.

Contrast this with another incident. A student on a check flight with an instructor was spiraling into the training field. At 500 feet altitude he let his nose come up too high and the plane lost flying speed. The instructor, fully aware of what was happening, nevertheless allowed the plane to fall off in order to impress the student with his error. He let it make half a turn of a spin, then eased the stick forward and stepped on the rudder. The spin was stopped instantly. A moment to gain flying speed and he pulled the nose up level again with hardly a hundred feet altitude loss. So far as he was concerned it was all in the day's work.

The difference is merely a matter of perception of flying speed. The student who crashed stopped the rotation of his plane, but did not give it time to gain speed before he tried to lift the nose. The premature raising of the elevators immediately threw it into another spin.

Lieut. Barrett Studley, U. S. N.

This process he repeated each time. The instructor, on the other hand, paused a second to pick up speed and came out under perfect control.

A skilled and experienced aviator is always instinctively aware of his flying speed. The feeling of it becomes ingrained in him. It is the very essence of his "feel of the air," the flying instinct that marks him as a competent pilot. He could no more miss the warning of an imminent spin than he could the screech of a fire siren ten feet from his ear. They fairly shriek at him. The controls become sluggish and the plane labors heavily through the air. In a spiral the hiss of the wires can be heard dying down. The approaching stall is obvious seconds before the plane can spin. It is not necessary for him to be giving his conscious attention to it. His arm will respond automatically to the sensation of decreasing speed by pushing the stick forward. The spin is stopped before it can ever start. Out of stunts, always executed at safe altitudes, he might spin accidentally. Out of an ordinary turn or spiral, never.

Modern engines seldom fail. But occasionally they do. What then happens depends absolutely on the pilot. Every competent aviator has it within his power to take adequate precautions against personal risk in case of engine trouble. If he is experienced and careful, he will be prepared for it at any moment. If it occurs, he will take instant and effective action, and, though the plane may be wrecked, he will climb out of it comparatively unhurt. Engine failure is not an excuse for a serious accident.

When the engine stops, the immediate vital thing to do is to nose over into a glide. In order to maintain flying speed, it is necessary to allow gravity to pull the plane. In effect, as already explained, it coasts down a long invisible hill. This hill must always be steep enough to keep the speed above the stalling point. Any attempt to flatten the glide will result in a stall.

The gliding angle of the average plane is approximately 4 or 5 to 1. That is, with the engine dead, it will cover four or five feet of distance horizontally for every foot of altitude lost. At an altitude of 2,000 feet, a circle some four miles in diameter is thus presented to the pilot. Anywhere within this circumference he can choose a field and, if his skill is sufficient, can land the plane in it.

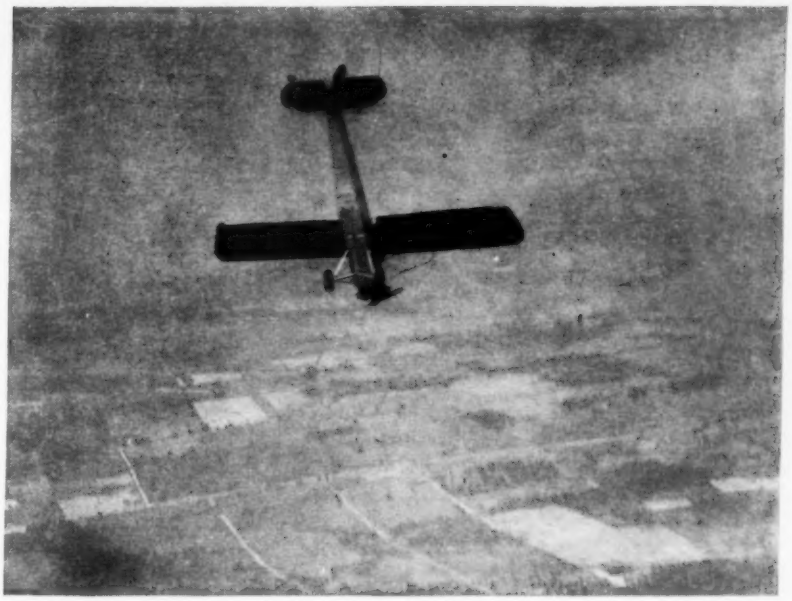
The preparations which a pilot habitually makes for engine trouble are as important as the actual handling of the plane after the engine stops. Engine failure is like fire. It happens very seldom. But when you find your garage ablaze it is a trifle late to order a fire extinguisher. And when your engine stops it is also somewhat late to start looking for a place to land. The experienced pilot makes it his business to know at all times what is below him. And on any ordinary flight he chooses a course and altitude which will keep him within gliding distance of some open space continuously. It may be only a stump-dotted lane through the trees, a patch of low scrub or a sandy beach. But at least a landing could be made in it without personal injury.

The intelligent and careful pilot never takes off directly over buildings or high trees. He never flies low over cities or towns nor, except on flights which necessitate it, over thick forests, lonely expanses of water or any other terrain where a landing could not be safely made. When he starts cross-country he

climbs to a safe altitude and selects a field ahead. Of the location of this he makes a mental memorandum. As it passes beneath and drops behind, he selects another field ahead, then a third, and so on. Thus at all times he knows which way to turn in an emergency.

A lot of work, of course. And for months, possibly years, it is apparently useless work. But one day the engine stops. Two seconds later he is headed for his field. A minute more and he steps out of his plane unscratched. And needless to say he appreciates that field.

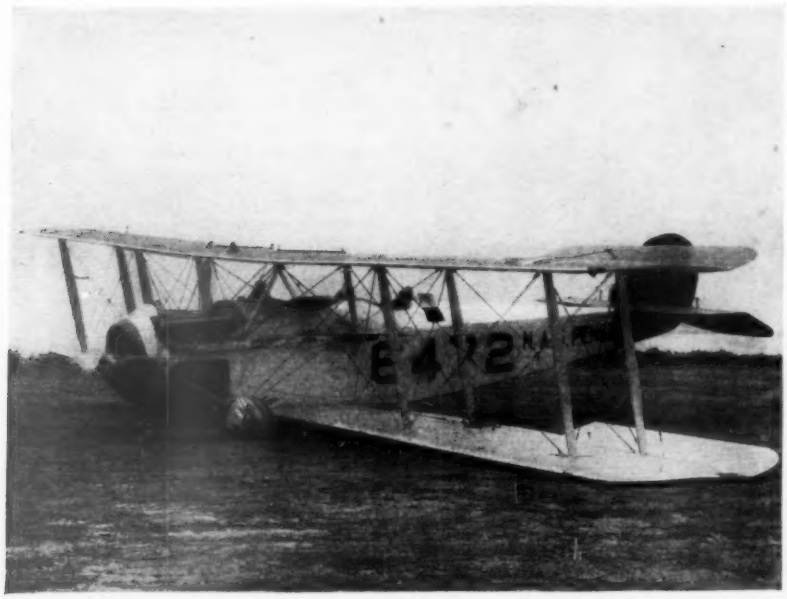
In order to land in a field with a "dead stick," as the propeller of a dead engine is called, the plane must be spiraled and side-slipped into a suitable position. As the landing must be made headed as nearly into the wind as possible, the proper procedure is to maneuver the plane into a position headed downwind at about 1,000 feet altitude with the selected field directly to one side. A gradual spiral, forming approximately the arc of a circle with the field as a center, is then entered. As the plane swings round to leeward, the pilot can choose what he considers the correct height for the final glide. At the proper moment he banks sharply, heads in toward the field and, if his judgment is accurate, puts the ship down in it. Whether the plane is damaged in landing is not a matter of primary importance. Naturally a pilot likes to save his ship if he can. But his personal safety must always come first. A landing in a poor field should invariably be made in preference to a doubtful attempt to reach a good one. If the plane happens to go up on its nose, that is unfortunate but not important.



"Nose her down and kick her out" is the rule in a tail spin.

But suppose a pilot misjudges his approach? Suppose he finds that he has gotten too far away from the only available field and cannot reach it? That circumstance must be accepted as a definite possibility. A forced landing requires a high degree of precision and there is ample room for mistake by even an experienced pilot. But even in this event there is still no reason for a dangerous crash. Serious injury is very unlikely so long as the plane is not allowed to fall vertically from any height. It is only a direct drop that causes fatalities. Collision with obstacles at or near the ground, though somewhat unpleasant, should not be dangerous. The competent pilot, if he misjudges his approach, will accept the situation and instantly select the clearest space within reach. Into this he will spiral or side-slip. And if it means cracking up the ship, he knows how to do it. With a brick wall ahead of him he could, by swerving the nose with the rudder, take the impact on the wing. The latter in crumpling would ease the shock. Or the plane might be side-slipped directly into the ground, wing first. A rather rough procedure perhaps, but hardly dangerous. And, as the old saying goes, "It's a good landing if you can walk away from it."

The end of a flat glide.



Why then do serious crashes occur repeatedly after engine failure? Purely and solely from neglect of the oldest law of aviation—keep flying speed. It doesn't matter how fast you come down. You can dive at two miles a minute, cock her up in a ninety degree bank or drop like a rock in a vertical sideslip. There is just one thing you can't do—stop and think it over. The plane is going to come down. And if you don't bring it down under control it will come down out of control.

That is the way accidents happen. The engine stops and the pilot looks around for a landing place. He hasn't been watching the ground very carefully, and a couple of good fields are just beyond gliding distance. The only thing within reach is a pasture surrounded by trees and fences. It isn't very big, but

he thinks he can reach it. But perhaps the wind is stiffer than he estimated and the plane is drifted too far down. Suddenly he feels that he has misjudged his distance. He swings up hastily into the wind and heads for the field. It certainly is farther away than he thought. And if he doesn't make it the plane is going to hit a fence. But he should make it all right. He holds the nose a little higher up to stretch the glide as far as possible. The speed drops. But his mind is fixed on that field. He must reach it. The plane is low now. But he must clear that field. He pulls the stick back a little further—. About that time he runs out of flying speed. The plane goes into a spin. The next day you read about it in the papers.

This student tried to turn back to the field with a dead engine.

That, with minor variations, is the way accidents happen when the engine stops. The one absolutely imperative thing is to keep flying speed. Fall out of the air and you're out of luck. But get down to the ground still under control and you can walk away from it.

The answer can be summed up in one word—training. Accidental spins come either from inexperience or from lack of aptitude. It is the business of the flight school to train the apt student and eliminate the inept. So far as loss of control in any ordinary maneuver is concerned, any tendency toward it marks a student as not qualified for aviation. The fact is that not all men can learn to fly. The majority can. But there is always a minority who cannot. A student, for example, never uses just the right amount of rudder in a turn. His spirals are a succession of slips and skids. He is never sure of making a good landing. At any moment a stall may creep up on him unrecognized. Obviously he lacks the feel of the air.

Or perhaps he handles the plane well enough in normal flight, but cannot keep up with an emergency. When the instructor cuts the throttle, he never knows just what to do. First he wavers uncertainly trying to decide which field to head for. He finally picks a poor one and tries to shoot it crosswind. His spiral is sloppy and the plane swings out too far. Then, trying to turn in hastily, he banks steeply and forgets his air speed. At the last second the instructor grabs the controls just in time to keep out of a spin.

An experienced instructor can estimate a student's aptitude with surprising precision. Sitting in the plane watching the student's work, he can read, not only the present quality of his flying, but what he is likely to do in a month or a year from now. Of course, there must always be border-line cases. Flying ability cannot be figured out like a problem in mathematics. But the aptitude of a great majority of students can be definitely determined. If the estimate is negative, there is only one answer—stay on the ground. Such a student should get out of aviation before he is carried out.

In military and naval flight schools the problem is simple. The training of unsatisfactory students is simply terminated. The results are suggested by a comparison. During the War little was known about scientific flight training and as many students as possible were rushed through the schools. At the Naval Air Station at Bay Shore, N. Y., during the week of Labor Day, 1918, there were nineteen accidents. In 1927 a large class at Pensacola soloed for five weeks before the first crash, a minor one, occurred. Careful selection and intensive training accounted for the difference.

In civilian flight schools the problem is not so easily solved. There seems to be no law to prevent a student from committing suicide by airplane. It is doubtful whether any legal solution is feasible. If a man is bound to fly he will probably do so until stopped by the law of gravity. But the majority of students can be assumed to possess common sense. They realize that they are not competent to judge their own ability. They want to know what the instructor thinks of them. It is the latter's responsibility to furnish such a student with an opinion based on the known standards of flight training. If a man has a weak heart, his physician tells him he must not fly. If his flying sense is weak, the same professional obligation rests on his instructor.

But even an apt student will probably go wrong on his first emergency. It takes a cool head and a steady nerve to shoot a small field with a dead stick. Nine chances out of ten the first try is not going to be so good.

Instruction in emergencies is a part of every adequate course of flight training. The instructor goes through it as a matter of routine. He has the student climb and skid the plane into stalls repeatedly. Before he soloes, the latter can smell a spin coming a mile away. The instructor likewise cuts the throttle in all kinds of positions. One time it will be just after a take-off; the next time three thousand feet up in the air. But, whatever the situation, the instructor's directions are simple. "The engine has quit on you," he may remark casually. "Better do something about it." Then he simply sits back to see what happens. The student picks a field and spirals and slips as best he can in the effort to get into it. If his approach is good enough, the instructor may let him land. If not, he simply reopens the throttle and goes on. But whatever the student does, he does it himself, unaided.

That is the kind of instruction which prevents accidents. After a student has been through twenty or thirty practice emergencies, a real engine failure is nothing for him to get excited about. He knows what to do because he has been there before.

Accidents will always happen in the air, just as they do on land and at sea. Fog, storm and the inevitable factor of human fallibility will ensure that. No amount of training can prevent a certain minimum number of casualties. But that number can be kept very small. The excess is preventable.

In aviation, the place to eliminate such casualties is in the flight school, before they occur. Flight training can be made very nearly an exact science. From any group of students, the proportion who

(*Continued on page* 96)

XUM

East for a Record

By Richard Fenton

CAPTAIN FRANK M. HAWKS swooped down from a clear, cold sky to land at Roosevelt Field, New York, and break the transcontinental non-stop flight record by 36 minutes and 1 second, at the same time giving the first long distance test to the new type of cowling for radial motors, developed by the National Advisory Committee on Aeronautics.

It was disagreeable and cold, and only a few hundred people were there to greet him, as he climbed slowly from his open cockpit where he had held the controls for over eighteen hours. A big raccoon coat had shielded him from freezing but his mechanic had fared worse in the cabin, having frozen two fingers and taken sick during the flight.

Commenting on the record breaking flight and the nearly disastrous weather, Captain Hawks said, "There were times when I thought we would be lucky to get down alive. It was so bad after we passed Rosswell, I was almost tempted to turn back. I didn't expect it to be all roses. Now that it is all over, I don't see how it could have been much worse. This is a most treacherous time of the year to attempt transcontinental record breaking.

"I tried to get up over the clouds. Past Rosswell I began to climb and traveled at altitudes from 8,000 feet to 14,000 feet. The fog was terrible. I couldn't see anything. Hour after hour I flew by my compass and tried to stay on the course. For twelve hours it was so thick I thought we were never going to see earth again. At eight o'clock in the morning I saw land for the first time in many a mile. It was rough mountainous country and I recognized it immediately as West Virginia. I was far south of the course, as I had expected to cross Kentucky. I veered to the north and again ran into a white wall of fog. I came down to a lower altitude, as I knew the country well over which I was flying, and struck a regular blizzard of sleet and snow. We plowed through this for some time and suddenly it cleared. Early in the afternoon I looked down and was relieved to find the small towns and cities rather close together. I opened the throttle wider and settled soon after on Roosevelt field for an easy finish.

"We had a wonderful experience with the new type cowling. It is unquestionably a decided step forward in solving the aeronautical problem of resistance. The Pratt and Whitney Wasp functioned perfectly and was cool all the way. The oiling system was noticeably improved also by the cowling, never rising over 70 degrees Centigrade."

The Lockheed "Air Express" is the first commercial aircraft to be equipped with the new cowling, which was originally developed by the National Advisory Committee on Aeronautics, and in the record flight succeeded in increasing the speed of the plane about 25 miles an hour.

Mr. Lockheed, designer of the "Air Express" made the following statement regarding the cowling, "We obtained the specifications of the new type cowling from the National Advisory Committee for Aeronautics and have spent several

Oscar Grubb, mechanic, and Capt. Frank Hawks, pilot, with the record-breaking Lockheed monoplane.

months of experimentation to adopt this advanced aeronautic development to our aircraft. The success of the new type cowling has certainly been demonstrated in the remarkable record breaking flight made by Captain Frank Hawks. We are very proud of Captain Hawks and his mechanic, Oscar Grubb."

Captain Frank M. Hawks, early in his air career, was an instructor and test pilot in the United States Army, serving there for a period of two years. He next became an air mail pilot and followed the mail routes in fair weather and foul for some time when the urge to be up and away possessed him, as it always appears to do, when there are new difficulties to overcome, new dangers to face and conquer. "The Hawk" began seeking new fields, and found them in Mexico, where he transported payrolls by air for the Texas Oil Company. California called next and Hawks answered. He purchased a sister ship to Colonel Lindbergh's Spirit of St. Louis and entered the National Air Tour of 1927. He placed well and then jumped to Spokane where he won first place in the Detroit News Air Transport event.

Last year "The Hawk" became technical advisor on aeronautics for the Texas Oil Company. Flying a huge tri-motored Ford plane of the Texas Oil Company, he won second honors in the 1928 National Air Tour. During that year Captain Hawks carried over 7,200 passengers as guests of the Texas Company without a single mishap.

Now, Captain Hawks, to climax an unusually interesting and eventful life, lowers the transcontinental non-stop record; gives a real test to aviation's latest development, steps from his plane, removes his flying boots and fur coat and dressed in a plain, well tailored business suit, remarks that he didn't have time to eat during his long "trick" at the controls.

The red and silver monoplane "Air Express" consumed, during its record breaking flight, 400 gallons of gasoline, and 22 gallons of oil. The plane was not equipped with special tanks, the surplus gasoline and oil needed being carried in the cabin and handled by Captain Hawks' mechanic, Oscar Grubb. The fuel was stored in the cabin in five gallon cans to facilitate handling. There were found to be 50 gallons of gasoline left in the tanks and it was estimated that the "Air Express" could have flown for nearly three hours longer, as the plane was considerably lighter nearer the finish.

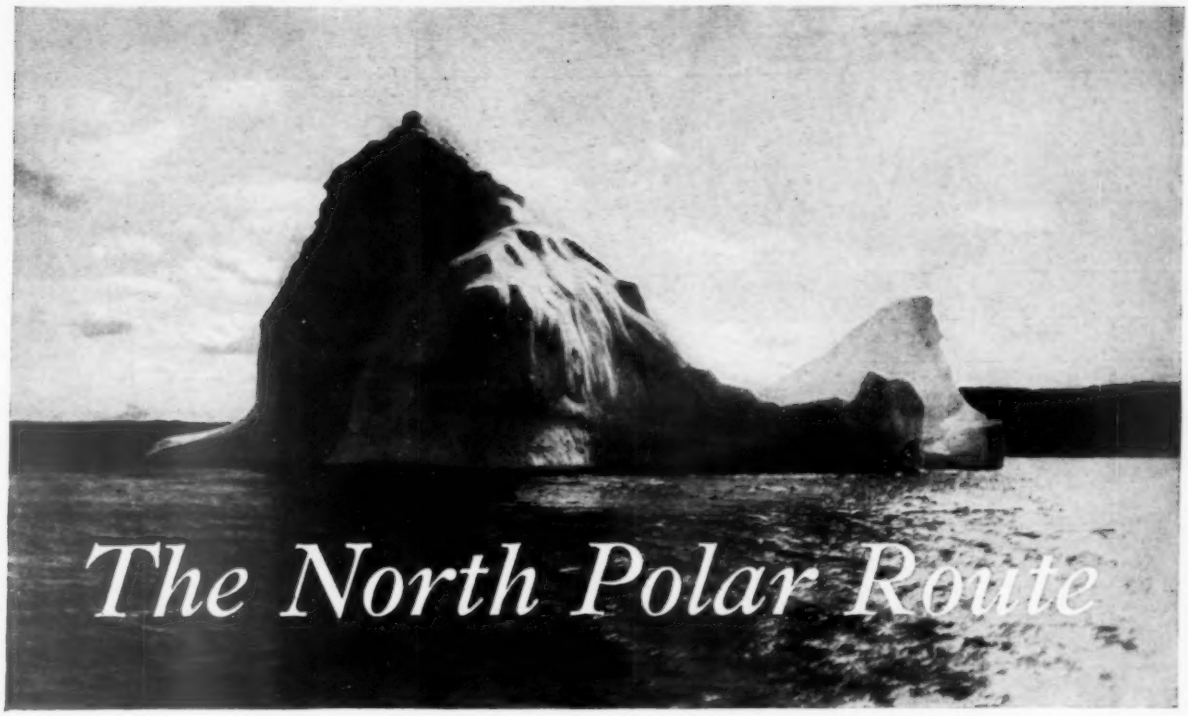
Captain Hawks got his heavy craft off the ground at Los Angeles after a run of 2,300 feet, with a load of 3,502 pounds, exclusive of the weight of the ship, which is 2,500 pounds unloaded.

The flight took 18 hours, 21 minutes, and 59 seconds and beat the previous record held by Colonel Arthur Goebel by 36 minutes, and 1 second. The average speed for the approximately 2,700 mile flight was 150 miles an hour. The take off was from Metropolitan Field, Los Angeles, California, at 5.37:30 p. m., Monday, February 4th, 1929 and the finish was at Roosevelt Field, New York, at 2.59:29 p. m., Tuesday, February 5th, 1929.

It is worthy of note that the record previously held by Colonel Goebel was also made with a Lockheed monoplane, though the Yankee Doodle was not equipped with auxiliary cowling or fairing.

Joe Nikrent, who clocked the Question Mark endurance test, timed the flight for the National Aeronautic Association.

Capt. Hawk's Air Express model Lockheed before installation of the cowling.



The North Polar Route

A Labrador iceberg along the coast of the Ungava peninsula.

By Lieut. John T. Rowland,
U. S. N. R. F., F. A. G. S.

AS the plane flies, the distance to the peninsula of Denmark in west central Europe is identical from Cape Hatteras, Chicago, Fargo, Skagway and Nome. If you do not believe it, test the matter out by stretching a string across an ordinary schoolroom globe. Hold one end firmly on Denmark and with the other swing an arc across the North American continent, commencing a little below Hatteras on the Atlantic coast. You will find that the statement above is substantially correct, allowing a trifle perhaps for unequal stretching of the string. The distance thus measured is approximately 3,600 miles, or considerably less than that from Nome to New York over existing routes.

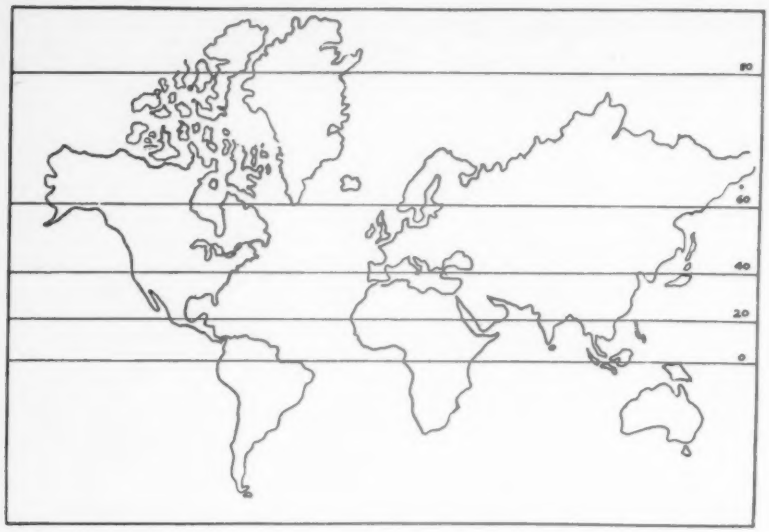
It is difficult to visualize this surprising neighborliness so long as one thinks of the earth as represented on our ordinary maps, but if one stands looking down upon the north pole of a globe the effect is quite different. It will be seen then that the land masses of the northern hemisphere lie grouped about the Arctic ocean. This is the new Mediterranean, a sea "in the midst of land." Compared with the huge bulk of Asia and North America the Arctic ocean seems insignificant and the aptness of the term becomes apparent, so much so that the name *Arctic Mediterranean* has already appeared on Circumpolar maps.

It so happens that most of our ordinary maps are based upon what is known as the Mercator projection. The effect of this is to flatten the earth's surface, with a tremendous distortion of the parts lying farthest from the equator. These portions are made to appear very much larger, relatively speaki g, than they actually are, and the distances between them correspondingly immense. On the other hand, the equatori l and temperate zones are shown in correct proportion. So long as man's chief interest lay in the latter regions no great harm was done, although it has perhaps given most of us a quite wrong idea about the size of Alaska as compared with the United States. Now, however, it is high time to correct these wrong impressions, and geographers must prepare other and truer maps. Instead of looking at this world from an imaginary point off in space somewhere over its equator we must try to visualize it from a point above the north pole. Since all attempts to represent a rounded surface upon a flat sheet of paper inevitably result in distortion, the only way to see the thing as it really exists is upon a surface modeled after the original. So let us return to our globe.

Next to the surprising propinquity of Asia, Europe and Alaska, the thing which most forcibly strikes us is the difference in habitability between Far-North America and the other countries which border the Polar seas. Both Alaska and Norway support an abundant population, with flourishing towns that lie well north of the Arctic circle, and in Russia and even in Siberia the settled regions reach far into the north; yet above our own country there is a vast unsettled region almost as large as the United States and lower Canada rolled in one. Indeed this hemisphere of ours, excepting the west coast, is virtually uninhabited north of a latitude corresponding to that of London. Of course, there are local exceptions to this statement, but generally speaking it is true. If like conditions existed in Europe there would be no population to amount to anything north of France.

This is a curious situation, arising from the inequalities of climate in different parts of the earth, and it has tended still further to distort our ideas. We think of Greenland as being nearly at the north pole, whereas actually its southern tip lies only a trifle farther north than Scotland. Baffin Land, which to most of us is merely an island somewhere in the Arctic waste, corresponds in latitude with Norway; and the city of Quebec is actually farther south than Paris. This is at first rather hard to believe.

Accustomed as we have grown to disregard everything north of the St. Lawrence River, our knowledge of the vast country between us and the real North is very slight and mostly wrong. When the airplane "Greater Rockford" left civilization on its flight to Greenland it had to traverse a territory larger than France



Sketch map to show the distortion of the Arctic regions on the Mercator projection.

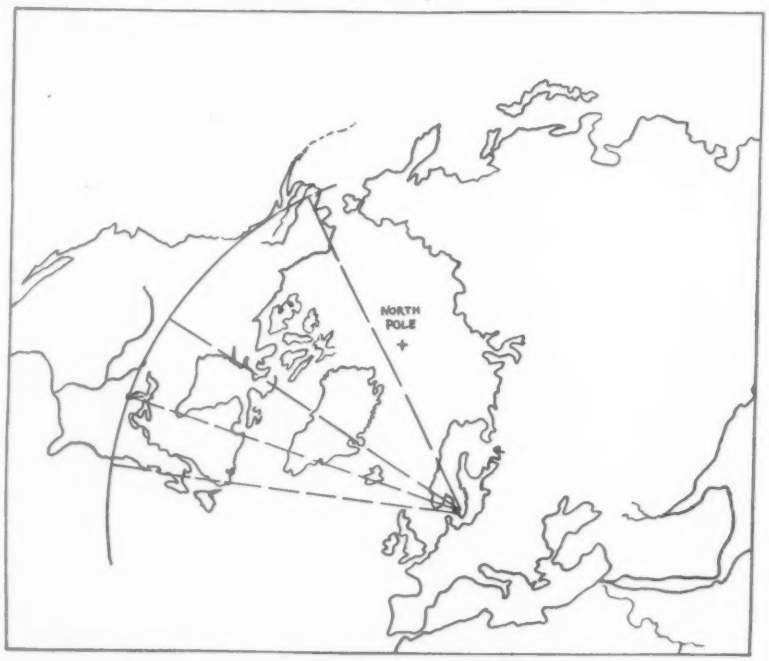
and Spain combined before it even neared the Arctic Circle. This country is the great Ungava peninsula, lying north of the St. Lawrence River and east of Hudson Bay. It is a land of abundant forests, and it is rich in mineral deposits, although the surface as yet has merely been scratched here and there. Situated within a few hours' flying time of our own northern border, its interior is still practically unknown. It is a country which should interest all women, since it is the supply source of much of the finest fur. On the north it is bounded by Hudson Strait, which the "Greater Rockford" probably passed, winging northeastward across Davis Strait. In all likelihood her pilots glimpsed the eastern extremity of Baffin Land, where Resolution Island stands guard at the mouth of Frobisher Bay, before squaring away for the Greenland coast some three hundred miles ahead. And even then they were only a trifle further north than Petrograd, in Russia. Had they been flying in Europe their course all this time would have lain over farmland and towns.

Yet, for all that our great American northland presents so uninviting an aspect, it need not raise any serious obstacles to commercial flight. For several months of the year its coasts are accessible to ships, and it would be a simple matter to establish stations for fueling and repair, with rescue vessels and planes standing by. The need for these is not due to any unusual flying hazard peculiar to this region, but because on those rare occasions when a forced landing might occur there would be no help available from local sources. That, of course, is the real difficulty with air routes over uninhabited country. Yet to picture this region as a snow covered waste is very far from the fact. Northeastward from the Great Lakes lies a narrow farming belt, beyond which some two hundred miles of unbroken forest stretch to the shores of Hudson Bay. Crossing to the east coast of this great inland sea the pilot finds himself above seemingly interminable forests of spruce and fir, broken by rivers and lakes. It is a pleasant, rolling country of moderate elevation and a climate which in summer suggests that of northern Maine. No white man lives in the interior and there is not so much as a trail by which to find one's way out; but the land is neither forbidding nor cruel.

Fish abound and game, if not plenty, is sufficiently in evidence to supply one's needs, especially waterfowl, several varieties of grouse, rabbits and bear. Any sportsman would find it an ideal vacation ground, though the terrible mosquitoes would worry him for a month or two in summer. Further north the trees gradually dwindle away till one reaches the barrens, an elevated plain of grass lands where if one is very lucky he may see a wild caribou herd numbering thousands of heads. North again of this lies Hudson Strait. On the whole route thus far there is scarcely a place where an amphibian plane might not find a safe landing or where its occupants would be exposed to any great hardships, provided they were rescued within a reasonable time. This applies, of course, to what we may term the navigable season, extending roughly from June to October, inclusive. The Canadian Government is beginning to realize that this country possesses great natural resources, and if air routes are established across it a rapid development is certain to follow, since inaccessibility is all that has delayed the process thus far.

Such is the general nature of the terrain a plane must cross in flying from any of our midwestern or central States towards Europe by the sub-Arctic route.

Alaska, North Dakota, Illinois and Newfoundland are the same distance from Denmark by air line through the Arctic.



After leaving the American coast astern at Cape Chidley one has next a short overseas flight to Greenland. The crossing of that great island at an elevation of several thousand feet, flying over an ice cap resembling a frozen sea, presents perhaps the most perilous stage of the journey. Then comes an overseas hop of roughly five hundred miles to Iceland, and another slightly longer one to the Orkney Islands, north of Scotland. From this point there is a choice of routes via the British Isles or the North Sea, depending upon the ultimate objective. It is to be noted, however, that nearly one-half of the entire distance along this route lies within the continental limits of North America.

The farther north and west one's starting point, the more formidable the venture becomes, until with Alaska as the jumping-off point the entire course lies over the true Arctic, where a mishap of any sort would almost certainly be fatal.

An Eskimo kayak off Cape Chidley Island, as photographed by the author.

A rapid stream in the interior of Ungava, the great peninsula lying north of the St. Lawrence River and east of Hudson Bay.

It does not seem likely that Captain Sir Hubert Wilkins' supreme feat of flying from Alaska to Norway over the Arctic Ocean will be emulated until planes and motors have been made far more reliable than they are today. But between this hazardous route and the one followed in part by the "Greater Rockford" there are numerous potential air lanes linking our north-central States and the western Provinces of Canada with Europe. The noteworthy fact is that they place those hitherto remote regions on a parity with the Atlantic seaboard so far as distance to the Old World is concerned.

Black and Bigelow Student Aeronautic Prizes

Announcement has recently been made by the Aeronautic Division of the American Society of Mechanical Engineers of three annual awards to be known as the Black and Bigelow Student Aeronautic Prizes which are to be offered to engineering students for the best papers submitted on the subject of Civil Aeronautics. First prize is $60.00, second prize is $25.00, and third prize is $10.00. The prizes are intended to encourage students to give more serious consideration to the problems facing the aeronautic industry. Papers may deal with the historical, analytical, experimental, or practical aspects of the topic, and may have to do with aerodynamics, airships, airports, airways, aeronautic instruments or equipment, management, airplane design, power plant design, aircraft operation, air transportation, aerial photography, etc.

Persons submitting papers must be student associates of the A. S. M. E. in good standing. The paper to be eligible need not be especially written for the contest, but may be a graduating thesis or a paper prepared for some meeting of the Society, including Student Branch meetings. It must not, however, have been previously contributed to or published by any other society or technical publication. Papers are to be submitted not later than June 30 of each year.

At a post of the Hudson Bay Company in Ungava.

Aerial Mapping in Mexico

By Kent Sagendorph

THE life of an aerial photographer is not the dizzy round of pleasure and adventure which fiction writers attribute to everyone whose job takes him into the air. Flying strip after strip at the chilly heights of a couple of miles or so is quite different from quiet cross-country sight-seeing, and is likely to become so monotonous that one glance out of the window at the same old scenery is enough to convince the photographer that he should have become a plumber, or taken up the study of phrenology.

One of the most successful of the country's flying cameramen is Sydney Bonnick, recently returned from Mexico after completing the photographing of a 2,400 square mile area for one of the country's leading industrial concerns. Mr. Bonnick originally came from England, having served in the Royal Air Force as both Pilot and Photographer, and in 1916 was sent to Canada to instruct the Canadian Air Force in the delicate art of wielding the camera. He has been at the business since 1910, when the highest development of the art consisted of leaning over the side of a balloon basket with a Graflex. Shortly after the war, he migrated to New York, and for the past several years has been on the photographic staff of the Fairchild Aerial Surveys Co.

"I don't think the majority of persons who read the papers know there is such a profession," he remarked over a cup of coffee. "I always am reminded of the official communiques the British Army used to issue during the war. They read somewhat like this: 'Capt. the Hon. So-and-So, V. C., D. S. O., A. F. C., etc., last Tuesday was engaged in battle over the enemy lines with 10 enemy aircraft. After putting up a very heroic fight, in which he shot down four enemy machines, he himself was brought down in flames behind the enemy lines.' Then follows a detailed description of his career, his boyhood life and probably the maiden name of his mother. Just as an afterthought, there would be a notation like this:

"'P. S. The Photographer was also killed.'"

Bonnick himself is not one to care whether the public notices him or not. After having served in the British, Canadian and American forces during the war, and for ten years afterward in civilian flying, he has few illusions left concerning the photographer's share of the spotlight. He takes it for granted that everybody will applaud the pilot, and ignore him completely. His record of achievement in Mexico, however, entitles him to the fullest recognition by the entire aerial fraternity, and leaves a record for all aerial photographers to shoot at.

In July, 1928, the Fairchild Aerial Surveys Co. was awarded a contract to map an area of approximately 2,400 square miles, in the vicinity of Tampico, Mexico. This area was being considered by an American industrial concern, whose field survey crew, composed of surveyors, geologists and engineers, had been cutting their way for some weeks through the dense vegetation which covered the territory. No appreciable gains had been

made. It was discovered that the field crew, aided by a small army of peons armed with machetes and hatchets, had been hewing their painfully slow advance parallel to a dry river bed a quarter of a mile away, of which they were blissfully ignorant. After this discovery, the firm decided that the aerial survey was the only means of getting the map finished by the present generation, and lost no further time in contracting with the Fairchild Aerial Surveys Co.

Cameras and supplies were shipped to Tampico, along with developing equipment and printing frames. Bonnick and the pilot, E. J. Snyder, also of the Fairchild staff, went by train to Chicago in order to avail themselves of a specially equipped Fairchild FC-2 Wasp motored monoplane which at that time was quartered in the Windy City. The flight to Mexico began from Chicago and required 17 hours and 10 minutes of actual flying time, with stops at Dallas, San Antonio and Brownsville, Texas. Leaving Chicago early in the morning, Snyder and Bonnick enjoyed a comfortable, serene excursion via air to Dallas, which was reached in time for dinner in the evening. The big Fairchild held its course, flown at a fairly low altitude, without much effort on the part of the pilot, and an average speed of 100 miles per hour was easily obtained on this initial stage of the trip. Dallas to San Antonio was flown the following afternoon, after a short delay in Dallas while the ship was being inspected and serviced.

The following morning, the second after leaving Chicago, Snyder and Bonnick again took to the air on the third stage of the flight to Tampico. Shortly after leaving San Antonio, Snyder became aware that all was not well in the air through which he was passing. The atmosphere had all the symptoms of a storm area, but no signs of a disturbance were visible to him. He was not kept in blissful ignorance very long, however, for he suddenly found the ship in the midst of a sand storm, familiar to all Texas pilots as a "norther." Snyder pushed the ship to 8,000 feet, hoping to rise above the great clouds of sand which enveloped the monoplane, obscuring his vision and sifting in the cabin around the doors and windows. Even at this altitude, however, the air was thick with flying sand; the ship plunged and rolled like a lifeboat in a heavy sea, and Bonnick, in the rear of the cabin, was thrown from one side to the other; batted around, as he says, like a cricket-ball.

Scene of the struggle between Cortez and Montezuma: Popocatepetl, Mexico's foremost landmark.

Glimpse of a ruined Aztec city.

The "norther" gave indications of rising three or four thousand feet higher than the altitude Snyder was holding. He thought it best to ride through it, if possible, because it was blowing in the general direction of Brownsville. While this gave him an average of 140 m. p. h., it put several additional bruises on various parts of Bonnick's anatomy, and the supply of unused spots was beginning to run low. There were still a few left, however, when the ship was finally set down at Brownsville.

The two men dug the sand out of their ears, swept out the cabin, the floor of which had been plentifully covered, and took off again for the last hop, to Tampico. Crossing the border, the big monoplane droned down the coast of the Gulf of Mexico, over innumerable tiny lagoons which dotted the shore line, past irregular rows of sand dunes, topped with low, stunted bushes, and over long stretches of sandy beach. Looking over toward the mountains, Bonnick was startled to observe a flock of wild turkey winging their way northward. On closer approach to the jagged Sierra Madre range, wild deer were seen leaping from crag to crag, or whatever it is deer amuse themselves by doing.

Before any photographic work could be done, after arrival in Tampico, a base had to be selected and temporary quarters erected to house the laboratory and

Dense underbrush makes surveying difficult along the lower slopes of mountains.

developing room. Bonnick called in an old Mexican carpenter, and together they constructed emergency buildings for their apparatus. Pipes for water and gas were arranged for, but when Bonnick saw the prodigious speed with which the peons were laying his pipe lines he felt called upon to do something to expedite matters. Apparently the Mexican labor gang couldn't do anything but rest up between siestas. Vehement protest in English merely resulted in an eloquent shrug of Mexican shoulders, and occasionally a lifted eyebrow. Bonnick seized a spade and made motions to illustrate the proper technique of trench-digging. A great light of comprehension burst upon the laborers. Ah, yes; the senor was going to assist. Very well, here was also a pick for the senor. They were delighted to welcome him into the trench-digging profession.

About a mile of pipe-line was laid to the buildings. Bonnick, who had been helping with the work, knew every detail of those lines, or so he believed. Imagine his embarrassment, on turning on the water over his sink, to find that he had crossed the lines in some unexplained fashion, and that flames burned merrily in the sink while the lighting fixture in the center of the room spouted water like Old Faithful Geyser.

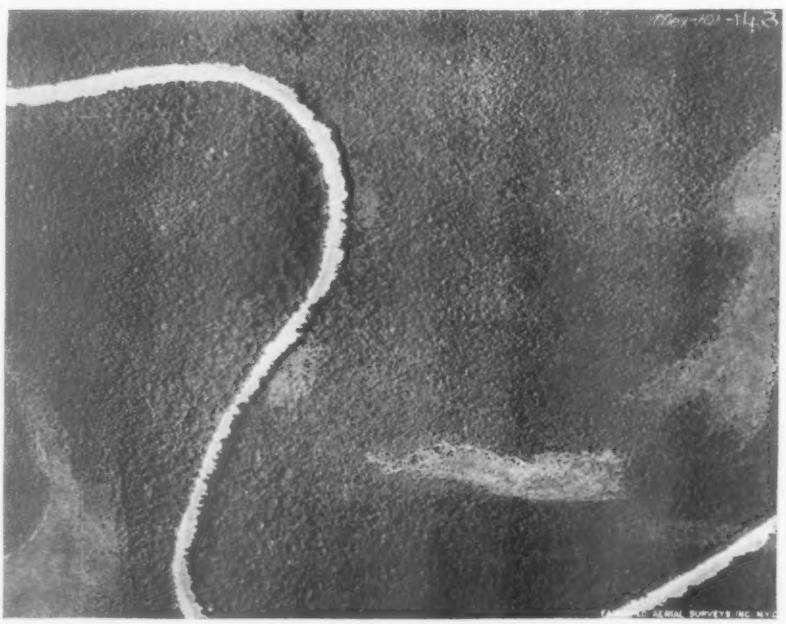
A further annoyance in connection with the pipe-line was the temperature of the water it contained. A thermometer showed that it flowed forth at about 95 degrees, which, as every photographer knows, will do all sorts of queer things to a film except develop it properly. Some means had to be provided to lower it to 65 degrees, the maximum allowable for sensitized film of this kind. Bonnick and the aged carpenter therefore constructed a frame ice-box, with sawdust walls nine inches thick and lined with sheet iron. Inside of this so-called refrigerator, he ran a small beer coil which had been purchased from one of Tampico's thirst emporiums. All the space around the coil was packed with ice, running up the ice bill to huge figures. This contraption used from 800 to 1,000 pounds of ice a day, but it did provide cold water for the developing tanks. Whenever the water was turned on in the darkroom, the ice would fold up and disappear.

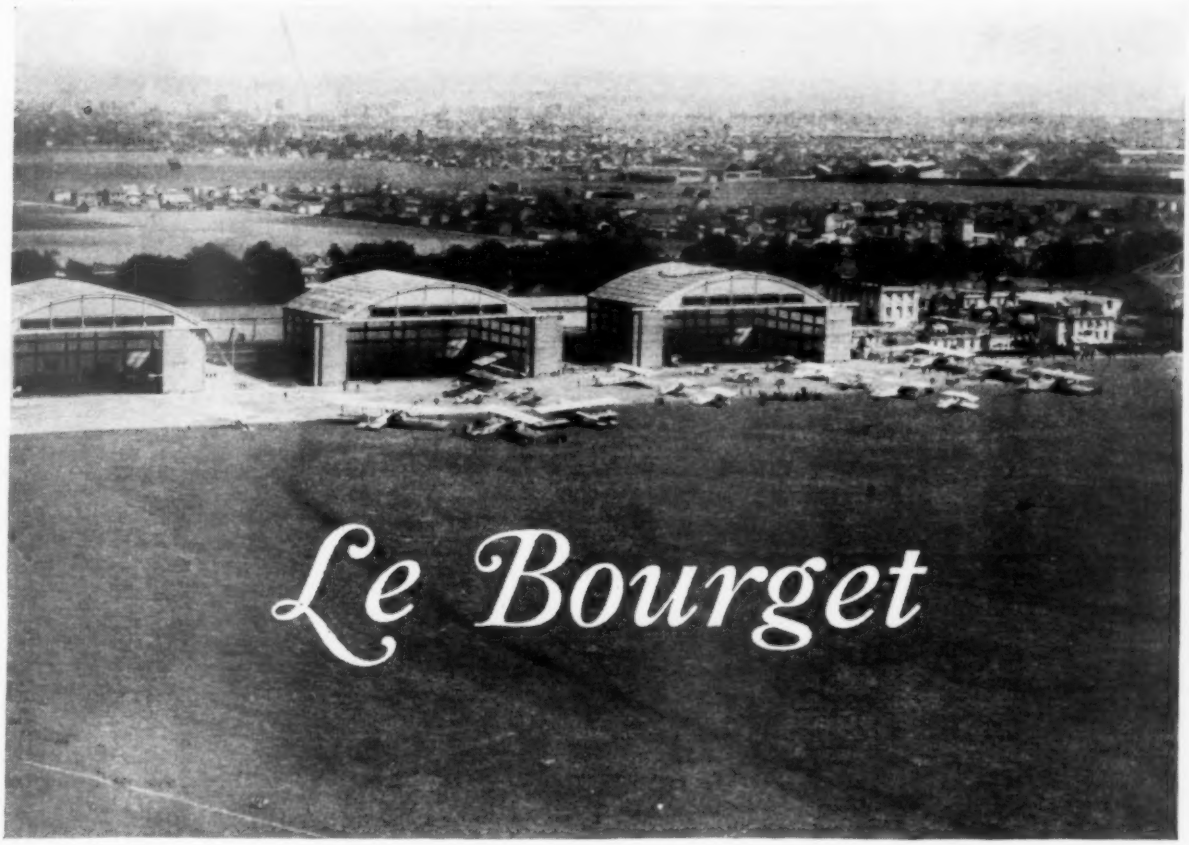
There was also the question of where to get lumber to build a long table, used for assembling and mounting prints. In building the structures and the refrigerator, all the available lumber of the district had been disposed of, apparently, and finally the superannuated peon was consulted as to possible clues. He said he had an idea; that he would go out of town and cut some standing timber. He hoped it would be all right for the tables, he said, and he would bring back as much as he could. He returned with solid mahogany logs. He said that mahogany was the cheapest he could get, and proceeded to construct the tables Bonnick had described. As a final gesture he gave them a glowing, dull-rubbed finish, and every time Bonnick spilled developer on this mahogany furniture he felt as if he had robbed the baby's bank.

During this period of construction, the cameras, developing tanks, printing equipment and various forms of photographic apparatus had arrived. Bonnick fitted an 8½ inch lens on his Fairchild mapping camera, and set out with Snyder for the field of operations. He knew that it lay at a great distance from the base, amounting to 150 miles in some cases, but he was not prepared for the blanket of clouds which greeted him on his arrival. Several times Snyder piloted him to the territory to be mapped only

(*Continued on page* 94)

Mexican scenery from an altitude of 15,000 feet. Jungles like this prove distinctly irritating to ground surveyors.





Le Bourget

By Paul E. Lamarche, Jr.

LE BOURGET, the airport of Paris, is probably the best known of all European airports to Americans. As a goal for trans-Atlantic flyers it has become associated with American achievements in the air more than once. A Ryan plane landed there on a direct flight from New York. A Bellanca has landed there after crossing the ocean, and last summer a Fairchild took off from this field piloted by Collyer who, with Mears, circled the globe in twenty-three days. Every year thousands of Americans use this airport when they come to Paris or leave by the route of the skies. To Europeans it is one of the three most important airports of the Old World, together with Croydon in London and Templehof in Berlin. To France it is her premier and most important airport and to her people this field associates itself with some of her greatest efforts and most successful endeavors in the air. It was from this field that Nungesser and Coli in a Levasseur biplane took off early one morning in May of 1927 and it was from this field that Costes and Le Brix took off on a trip that carried them across the South Atlantic and over two hemispheres before they again brought their faithful Bréguet "dix neuf" down on the sod of this field amidst the acclaim of thousands.

The Le Bourget airport is one of the most important air centers of Western Europe and its location has largely brought this about. It is the principal air field of the second largest city in Europe, with a population in excess of three millions, and a location that is, as every one knows, very central. Air lines radiate in every direction from this field in daily services and it is visited by the planes of many nations in the maintenance of these services. The airport is situated twelve kilometres from the Opera which is the heart of Paris and six kilometres from the Porte de la Villette, the northeastern extremity of the city limits through which passes the Route de Flandres, an important highway that continues past the air field in the direction of St. Denis. The field is actually just beyond the small town of Le Bourget-Dugny from which it derives its name.

According to French history two massacres took place in Le Bourget during the Franco-Prussian War in October and December of 1870 so that besides being famed for its airport, Le Bourget is thus recognized and known in Europe. Before the war the land which is now one of the finest airports of Europe was merely farm land outside of the town and at that time much of the flying around Paris was from the old field of Issy-les-Moulineux which, though now abandoned, retains many historic associations with early French aviation. It was at this old field that Farman made the first flight in France in a plane built by Gabriel Voisin twenty-five years ago.

During the war the French Government took over various tracts of land in the Paris region to use as airports for military operations, among them being the field at Le Bourget. Le Bourget was built as a military port and known in French army parlance as a *"réserve générale d'aviation"* which means that planes and forces were assembled there before going to the air stations at the front. It was also used for air squadrons whose duty it was to protect the city of Paris from air attacks. Though not at the front this field saw much activity as a military field and it was used alike by big Farman bombers, Caudrons, and other large planes as well as the little Spads with their now old fashioned rotary motors, that bore the brunt of the work among French combat planes.

A Fokker VII-A of the K. L. M. warming up its motor before leaving Le Bourget for Brussels, Rotterdam, and Amsterdam.

After the cessation of hostilities many of the air fields developed during the war were discontinued but it was decided to maintain the Le Bourget field and improve its equipment because of its important position. With the advent of commercial aviation and the fact that this field was one of the most conveniently situated to the city of Paris an extensive building program was begun in 1919 and it is from this beginning that Le Bourget has reached its present importance as an air center. At the close of the war most of the military hangars were situated at the western side of the field, and for this reason new buildings and civil hangars were erected on the eastern side, along which extends the Route de Flandres which is the most accessible and quickest thoroughfare into Paris. The airport did not reach its present state of development until after 1922 when the new hangars and equipment installations were finished. Since then various improvements have been made from time to time so that the airport is modern in every way. With the appointment of M. Laurent-Eynac as Air Minister of France following the death of M. Maurice Bokanowski in an air accident last summer, many important changes are expected at this field as well as in other branches of French aviation.

The field itself is approximately 325 acres in area. The ground is usually always in excellent condition except at times during the winter when the turf is soggy and ten ton commercial planes leave deep ruts behind them in taxiing over the field. It is very level, and compared with many airports, the surface is smooth and free of stones or depressions in the turf. In shape this field cannot exactly be called square but rather is suggestive of the shape of the state of Nevada as it appears on a map though Le Bourget is perhaps not so angular. Although the field assumes more or less the shape of a rectangle the southwestern corner makes the difference. The longest take off runs north and south and the greatest length in this direction is 1,500 metres or about 4,500 feet. At the southern end there are some low military hangars behind which is a row of poplar trees, while to the north there is no immediate obstruction rising from the ground, although there is a small stream known as the "Tranchée de la Morée" that winds its way along this boundary of the field and into which planes occasionally come to grief. The width of the field is at the widest point 1,000 metres or about 3,000 feet and hangars line both sides for the entire length of the field so that planes taking off across the field must allow for these obstructions. In all this air field is comparatively free of large obstructions and the country beyond is quite level for a considerable distance. The altitude of the field is 44 metres above sea level.

Military hangars line the western and southern ends of the field as well as a small part of the eastern side. At present some of the older hangars on the eastern side are being torn down to make more room for the development of civil flying. It is not definitely known at present whether new civil hangars will replace them or not for these few hangars being demolished are old and in poor condition and are not used. For the civil flying there are six large hangars of steel construction 33 metres wide by 42 metres long by 8 metres fifty centimetres in height. There are five hangars of similar construction 38x40x6 metres and five of concrete construction, which are the largest on the field, measuring 36x50x15 metres in size. Numerous windows along the upper part of the walls insure plenty of daylight while the heating of these hangars is by hot air from a central plant. The doors are opened by electric motors, which in the case of some of the older and smaller hangars are mounted on a supporting steel framework that runs along a track across the front of the hangar. The doors of the larger hangars open in several sections as the others though the application of the power of the electric motors is from the top.

In front of the civil hangars as well as the Administration Buildings and Customs office is an apron which is for the most part of cement. Most of the han-

A Farman Goliath of the Air Union and a Handley Page of the Imperial Airways arrive together from London, and discharge passengers and luggage in front of the customs office.

gars are occupied by the various commercial air lines which call at Paris such as the Imperial Airways of England, the Deutsche Luft Hansa of Germany, the K.L.M. Line of Holland, the CIDNA Line, the Air Union, the S.G.T.A. Line and the Compagnie Aërienne Française of France. The foreign as well as the French lines occupy their hangars exclusively for themselves and independently of each other and in most cases employ their own mechanics and other personnel. One of the hangars is occupied by privately owned planes as well as some that are used for instruction and other purposes though most of the privately owned planes are housed in the hangars on the field of Orly, also in the Paris region. In size these hangars were considered amply large enough for the largest of planes when they were built and they still are, but just at present the Luft Hansa is worried about the housing problem for a new Junkers that will be placed in the Berlin-Paris service and that will have a greater wing spread than the G-31 Junkers which they have been using on this route.

An idea of the number of commercial aircraft housed by the various lines at this airport is shown in the fact that the CIDNA Line (Compagnie Internationale de Navigation Aërienne) of France has as many as 69 planes in service though these are scattered over the routes they operate which extend as far as Constantinople. The Air Union which operates lines to London from Paris as well as to Marseilles and along the Riviera has a fleet of 28 planes among which are five Lioré et Oliviers, twelve Farman Goliaths, all large planes used between London and Paris, and sixteen of the smaller Blériot Spads which are used in France. Combined with the Compagnie Aéronavale which is a part of the Air Union their fleet of planes numbers 46. The S.G.T.A. (Société Générale de Transport Aërien) whose planes fly to the north countries as well as to Berlin has a fleet of 24 planes and the Compagne Aërienne Française has 50, of which some are flying and are operated in various parts of France.

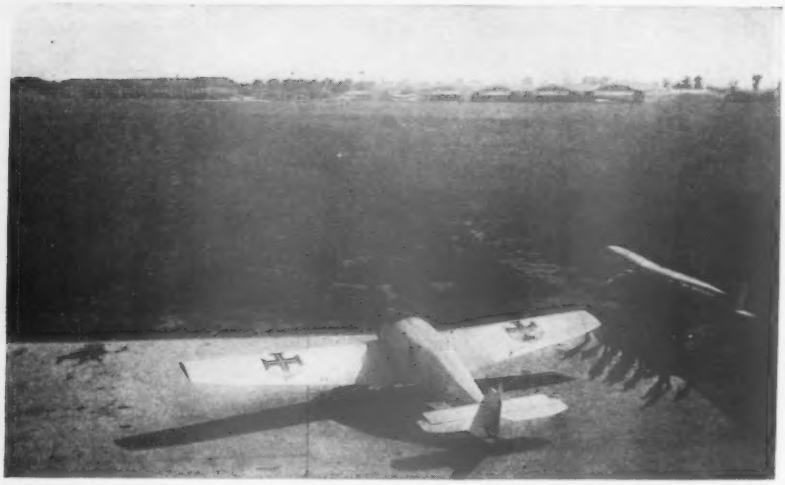
Le Bourget is identified from the air by a large white circle across which is written the word LE BOURGET. A smaller white circle near to the apron in front of the customs office can also be seen from a distance. Signal posts and wind cones are placed at various points along the borders of the field and serve for both the military and commercial aircraft. When a commercial plane arrives from a foreign country it taxies to the apron in front of the customs office where the passengers descend. Here passports are inspected and the travellers enter the customs room where the baggage is examined. They are then transported into Paris by a bus provided by the air line.

Paris to Berlin in five hours. This Junkers of the Luft Hansa is on the apron at Le Bourget waiting to fly to Germany.

Le Bourget is completely equipped for night flying and while none of the commercial lines using this port fly by night as yet, the field is equipped with the most modern lighting facilities. Several experimental night flights have been made between London and Paris and Strasbourg and Paris and at times the army planes practice night flying. Le Bourget is easily found at night and in good weather can be identified at a distance. At the airport is a large steel pylon or lighthouse that stands about one hundred feet high and on top of which is installed a projector and eight tubes of Neon lights. In clear weather and when flying at a good altitude the pilot can see these lights from a considerable distance. These Neon lights are the most effective type of lights used in European airports for penetrating through the fog and mists. The experience of Commander Byrd in the America when he vainly tried to reach this field during very bad weather conditions seems to show that even these lights are not good enough to conquer fog, but on the other hand there is much speculation as to whether he was actually near to Paris at any time before the end of the flight.

A large letter N illuminated at night identifies Le Bourget and this letter designation is particularly useful in identifying the field from the lights of the city and railroad yards beyond. A large letter T on a mast which is illuminated at night shows the pilot the direction of

One of the big hangars at Le Bourget with many types of aircraft ready to start out over the air routes of Europe.



A Junkers in the Portuguese service about to resume its trip from Germany to Portugal after calling at Le Bourget. Beside it is a French Nieuport Delage.

the wind while a system of colored lights on the roof of one of the buildings tells the night flyer whether the apron or "piste," as the French call it, is clear or not by showing green if free and red when occupied. Flood lights are placed at corners of the field as well as on the apron in front of the customs office. These lights are mounted on wheels so that they can be moved at will. At the extreme limit of the field is a powerful projector that is operated on a double circuit, that is, by the regular electric current on the field as well as by a gasoline set that can be used in an emergency if the current should fail. As on all air fields equipped for night flying, all obstructions such as the roofs of the hangars, wireless masts, boundaries of the field and other hazards are clearly marked with red lights.

While at present most of the night flying in France is done by the military service the French are installing a number of beacon lights between important cities so that night flying can be more easily accomplished. Near to Paris and to the west about twenty miles away is a powerful beacon on the top of Mont Valérien, a fortified hill. Mont Valérien is the highest hill in the Paris region and has a commanding position, its altitude being 136 metres high. The beacon on this hill is one of the most powerful aerial beacons in France. Between Calais and Marseilles there are at present eighteen beacons with Neon lights. Between Paris and Strasbourg there are seven, between Paris and Brussels there are two and three more are to be installed along this route. Between Paris and Le Havre there is at present but one, though plans of the Air Ministry will provide for more. There are also other aerial beacon lights at other scattered points in France and in particular along the Riviera coast as well as towards the Spanish frontier.

Probably one of the most important factors in the ability of European air lines to maintain their regularity in service is the excellent development of radio communication between airport and airport as well as between airport and aircraft. The installation at Le Bourget is one of 500 watts capacity and there are at present twenty-two stations in France of this capacity and fifteen of 100 watts as well as a number of smaller stations, mostly operated by the army service. A plane flying over any of the air routes radiating from Paris is able to maintain communication with this station for a considerable distance and radio installations at the airports of Europe are so well developed that the plane in flight is always able to communicate with some station and often with several at the same time. The radio equipment at Le Bourget as at all of the big commercial airports of Europe plays an important part in the operation of the field. Through it the officials are able to receive frequent weather reports as well as to advise the planes of prevailing weather conditions. Messages between planes and the fields are by word of mouth and the planes identify themselves by the letters which appear on their wings and fuselages. Three large steel masts at the north end of the Le Bourget field support the antenna from which messages are broadcasted into the atmosphere to guide the plane to its destination.

Of equal importance to the radio for the successful operation of air services is the weather bureau, and the "bureau météorologique," as the French call it, at Le Bourget is very complete. On two walls of a large room in one of the buildings are large detailed maps or boards showing all of the territory covered by the air lines of Europe. On one of these maps small metal plates are inserted in grooves in certain districts in much the same manner that a clerk in a broker's office indicates changes in the market on his board. These plates are covered by small slips in various sizes, shapes and colors to indicate various weather conditions prevailing in Europe. When a pilot examines this board, which is always kept up to date through constant communications with other airports and frequently with planes in the air, he is able to inform himself of the prevailing weather, the height and density of the lowest clouds and so on along his route. Many of the airports, especially those in Germany, send up a plane every day to make these observations and there is always an interchange of information between fields, so that each is informed of the others' weather conditions. Another large map has small metal arrows placed at various

General view of the military section of the Le Bourget airport.

points in Europe which tell the force and direction of the wind. They generally show the conditions at altitudes of 30, 100, 500, 1,000 and 2,000 metres. A number of smaller maps show the atmospheric depressions in various parts of Europe and are usually kept mounted on a small board for inspection. They are known as "cartes des isobares" by the French. The pilot before setting out over his route is thus always able to get dependable weather information.

An interesting installation at this airport is the medical building and its equipment. In it are all of the usual first aid requirements as well as devices for testing the physical qualifications of pilots. All pilots on the commercial lines must undergo a medical examination every six months and as usual, special attention is given to the heart, lungs and eyesight. In the basement of this building is an air tight chamber which is used for testing the lungs and heart action of qualifying pilots. By means of an air suction pump driven by an electric motor the air pressure in this chamber can be lowered to correspond with pressures found at different altitudes. By means of a small port hole the pilot can be observed during the examination. The heart is examined for any suspicious reaction after having passed through this test.

The Le Bourget airport is owned and operated by the French government. Until recently the field was managed by a government organization known as the "Service de la Navigation Aërienne" which was under the control of Maurice Bokanowski, the Minister of Commerce. The "administrateur" of the Le Bourget airport is M. M. Renvoisé who was appointed by this organization. M. Renvoisé before assuming the management of this important airport was connected with the Post Office Department in France of which M. Bokanowski as Minister of Commerce was the head. Since the death of M. Bokanowski and the appointment of M. Laurent-Eynac, a former member of the Chamber of Deputies and Under Secretary of the Air, as Air Minister, the "Service de la Navigation Aërienne" has become a part of the Air Ministry and M. Renvoisé, who continues to direct the airport, is now under the Air Ministry.

The organization under him is responsible for the maintenance of the airport in general and the operation of the weather bureau, radio department, and other departments. His is an organization that receives government support and supervision. The air lines themselves operate independently as well as the army section of this field and have their own forces of mechanics. The Air Union for example, has altogether 20 pilots and about 185 hangar men. The S.G.T.A. has about 40 men on the ground for the maintenance of their flying stock. The military force at this field has its own quarters for the personnel, as well as its own hangars. It is known as the 34th Air Squadron of the French Army and consists of five groups. The first four have a photographic section and two "escadrilles" of eleven reconnaissance planes each. The fifth group has three "escadrilles de chasse" (pursuit groups) and the total number of army planes at this field amounts to 124, most of which are Bréguet and Nieuport-Delage planes.

A well appointed restaurant and a café where the air travellers can enjoy a tall glass of beer for the equivalent of four cents are to be found at the field and it has been rumored that a hotel may be built there such as is to be found at the London field. All of the air lines have their own buildings at the field which serve as field offices and waiting rooms where passengers are weighed before boarding the planes waiting for them on the apron outside of the customs office through which the air travellers must pass. All of these companies have their own busses that carry their passengers and their baggage to the field from a central point in the city free of charge. A half hour is usually allowed for the trip from the heart of the city of Paris to the field and compared with many airports of Europe Le Bourget is fortunate in being convenient to the city limits. Ordinary methods of transportation from Paris, however, do not extend as far as the field and at present unless one is able to take a bus of one of the air lines or a taxi it is not easy to reach.

A tram line from the heart of Paris which ends in the town of Le Bourget is to be extended to the field and one of the municipal bus lines will also be extended. Mail is usually picked up by the busses on the way out from one of the central post office bureaus but just at present plans are under way for an air chute from the Pantin post office, one of the more important branches in the north of Paris, directly to a branch which will be organized at the field for the handling of mail.

Although Le Bourget is one of the three most important airports in Europe its air traffic is the least among the trio.

Breguet planes of the 34th air squadron of the French army ready to take off for manoeuvers.

Comparative figures which are given below show the extent of commercial air traffic that exists at each. These figures cover the period from January 1st to December 31st of 1927.

There are several other air fields in the immediate vicinity of Paris such as those at Buc, Toussus-le-Noble, Villacoublay and Orly. The French government is at present planning to enlarge the airports of Bron at Lyons as well as the airport at Marseilles. This latter airport has become more and more important as a commercial airport and one of the most important air lines from foreign countries passing through it at present is the Luft Hansa line from Geneva which continues to Spain and corresponds with the Iberia Line of Spain. It is also called at by planes of the Air Union and connections can be made there for various parts of the north of Africa.

	Le Bourget Paris	Croydon London	Templehof Berlin
Passengers	25,556	29,488	40,000
Freight	869 tons	1,498 tons	924 tons
Planes (arriving and departing)	6,247	6,554	16,620

Spying Out Engine Secrets

By George H. Dacy

BY placing thirty-one small quartz windows in the head of a one-cylinder marine engine, Uncle Sam has provided a plenitude of peep holes through which all that goes on in the automotive engine cylinder may be seen and studied.

Government experts utilizing scientific apparatus developed for that purpose can now spy on the throbbing, pulsating heart of the engine which runs the modern airplane, speedboat or motor car.

New facts about automotive engines, their processes and activities, and likes and dislikes, many of which have never previously been divulged and demonstrated now stand just off-stage awaiting their curtain calls. This remarkable research, fostered by the automotive division of the U. S. Bureau of Standards at Washington, promises to eliminate much of the guesswork heretofore inseparable from our fundamental body of knowledge about what the engine does and how it does it.

The feature of this novel experimentation which appeals particularly to the average layman is the fact that he can actually look into the test engine and see what occurs there during the sparking period, the ignition of the charge and the course of the flame propagation from the firing point to the opposite wall of the combustion chamber. It is an astonishing mechanical drama enacted on a restricted stage under conditions never before duplicated.

The head of the one cylinder engine is provided with 31 quartz windows for observation.

Some time ago the National Advisory Committee for Aeronautics enlisted the aid of the Bureau of Standards experts in studying and correlating the phenomena of combustion with the observed performances of actual engines. Mr. Charles F. Marvin, Jr., as a result worked out an idealized theoretical outline of what may happen in the engine cylinder during the burning of a charge.

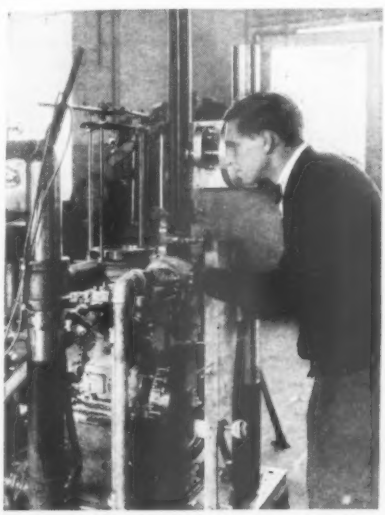
"When the intake valve of a gasoline engine closes," Mr. Marvin told this writer, "it traps a definite weight of charge in the engine cylinder. So far as possible leakage of piston and valves is ignored, and this weight is considered to remain constant until the exhaust valve opens. During the intervening interval, the trapped gases undergo extremely rapid chemical and physical changes which qualify them to do work on the piston. The amount of this work can be determined with fair accuracy and various tests prove that it varies measurably for different engine designs and operating conditions."

Determination of just what happens in the cylinder during the burning of a charge, to cause the observed variations in engine performance, continued Mr. Marvin, is rendered difficult and uncertain because of the complexity and speed of the chemical reactions and the presence of a number of operating variables, such as fuel characteristics, pressure, temperature, turbulence and piston movement, all of which influence combustion and complicate any such research activities. On various occasions, experiments with simple explosive mixtures in bombs under controlled conditions have yielded important data about the phenomena of combustion, but need has also long existed for supplemental information which will correlate the fundamentals of combustion with the observed performances of actual engines.

Mr. Marvin went so far in his theoretical visualization as to draw a series of diagrams of sectional views through an engine cylinder at the spark plug. He assumed the presence of a homogeneous charge, a thin disk as the combustion chamber and no turbulence or piston movement. This theoretical conception shows how, after the occurrence of the spark, the charge begins to burn, its temperature rises and it expands, pushing the flame front ahead of it, compressing the unburned charge and causing a uniform increase of pressure throughout the cylinder. The flame front increases from zero to a maximum and then decreases to zero again as the flame advances across the cylinder from the spark plug to the opposite wall.

Of course the flame may not advance as a spherical surface in the actual engine cylinder. Its shape may be distorted by turbulence, stratification of the charge, by reflected pressure or sound waves or by movements of the piston. Under certain conditions, the whole of the unburned portion of the charge may be ignited simultaneously by either compression or incandescent particles. These possibilities logically invite additional research.

"From a theoretical standpoint, from the analysis of indicator cards, and from observation of actual engines," concludes Mr. Marvin, "it is evident that the time required for complete combustion of the charge varies considerably with different engine designs and operating conditions. It is also known that the rate of burning at any particular instant after ignition may differ even in cases where the total combustion time is the same. Both



Using the stroboscope to see what happens in the combustion chamber of the test engine.

the rate of combustion and the time required for the complete burning of the charge have an effect on the power and economy of the engine. The maximum power and economy are obtained in the theoretical case of instantaneous combustion at upper dead center. The

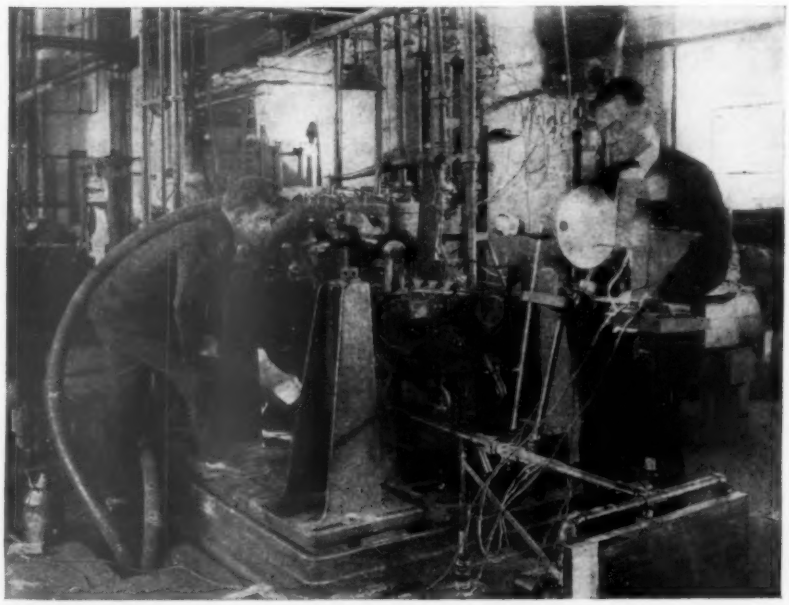
slower combustions obtainable in practice may result in considerably reduced efficiencies if improperly timed with respect to piston position. However, the maximum theoretical performance may be approached very closely with a wide range of combustion times and rates, provided the proper spark advance is maintained for each particular condition."

In order to study the movements of the flame in an actual cylinder, Uncle Sam has mounted and equipped a small single cylinder engine for research purposes at the Bureau of Standards. Thirty-one quartz glass windows are distributed symmetrically over the combustion space in a detachable cylinder head of special design. Each window is one-eighth of an inch in diameter, the glass being inserted between gaskets in a hole in the head. Light from the explosion passes through these windows to a seven-inch lens placed just above the engine. The function of the lens is to bring the rays of light to a focus at a stroboscope where they may be observed. A small mirror is employed to reflect the converging light beams from the lens to the stroboscope which, for convenience, is placed at one side instead of directly above the engine.

A stroboscope is best described as a device which slows down or even stops the swift motion of speeding mechanical parts. It aids scientific research in much the same way that slow movies of intricate football plays assist coaches in tutoring their players in such manoeuvers. In this engine research, the stroboscope consists of two rotating disks, each of which has a small hole near its circumference. Once during each cycle of the engine the holes coincide at the eyepiece of the instrument, affording the observer a very brief glimpse of the head with its windows. Thus this apparatus enables the spectator who peers into the gasoline engine's throbbing heart to get the same view over and over again many times a second, but always at the same point in the cycle.

The stroboscope may be adjusted to give the view one one-thousandth of a second after the spark has occurred. In such case only those windows close to the spark plug will be illuminated by the flame, the rest of the cylinder appearing dark. However, as the view is timed later and later, the combustion is seen to spread until finally the entire charge is aflame. By keeping tab on the quartz windows as they are illuminated in sequence, the progress of the flame may be charted and the effects of operating conditions and various fuels on flame movement and velocity may be studied. By still further retarding the view, it is possible to measure the time required for the flame to die out in the cylinder, leaving the combustion chamber once again in darkness.

Quartz peep holes allow inspection of the interior of the intake manifold.



An arc light illuminates the interior of the intake manifold during the examination.

An interesting feature of the setup is the use of a neon lamp, connected in series with the spark plug, so that it flashes every time the spark plug fires. Gauge marks on the rapidly rotating flywheel of the engine appear stationary when illuminated by the light from the neon lamp and are used to indicate the amount of spark advance. The stroboscope is set accurately on the beginning of the explosion when the flashes of the neon lamp are visible through its eyepiece.

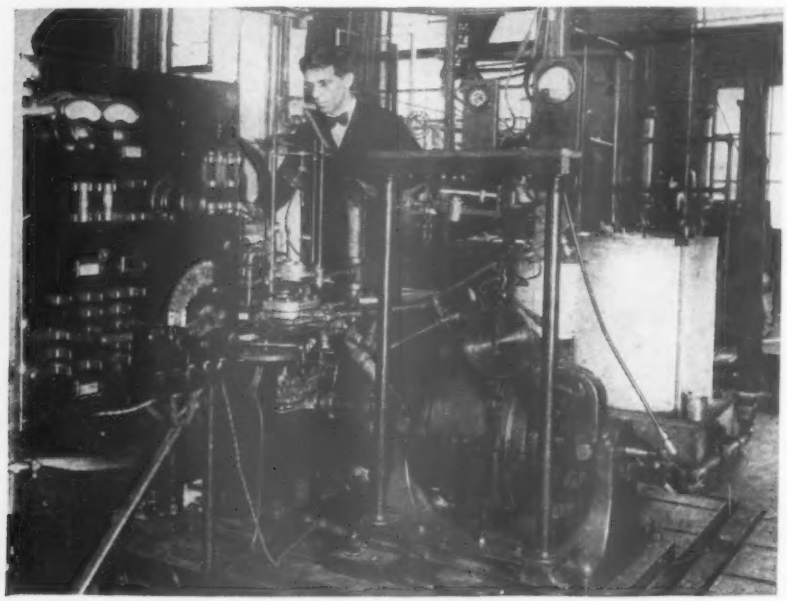
Not only the period of combustion, but also the interval preceding combustion, during which the explosive charge is drawn in and compressed, is of interest in engine performance. Hence the Government engineers have also rigged up a four cylinder engine for special research to determine what happens before the spark occurs. In this second experiment, a powerful beam of light

from an electric arc is directed through a quartz window into the intake manifold or into the engine cylinder. A second quartz window through which this beam may be viewed from an angle is also installed in both manifold and cylinder.

When an automobile engine is started, a gasoline fog exists invariably in the manifold, this condition being prevalent irrespective of temperature or season of the year. A fog in nature is nothing more than a cloud on the surface of the earth. The cloud in the engine manifold with its content of particles and fuel droplets scatters the light from the arc and appears luminous in the same way that moisture particles scatter the light beams from automobile headlamps when one drives into a fog at night.

When the fog from the manifold is drawn into the engine on the suction stroke it mixes with the hot remnant of gas from the previous explosion and comes in contact with the heated walls of the combustion chamber. This heating of the charge tends to vaporize the fuel, the dry vapor, unlike the liquid, being invisible just as clear air is invisible in the rays of auto headlights. By setting the stroboscope, which is mounted on the test engine to give a view into the cylinder at the end of suction stroke, the degree of wetness or dryness of the charge which is about to be compressed can be estimated.

Compression by the piston on its upward stroke adds more heat to that which the charge has already absorbed from the hot walls of the cylinder. The resulting rise in temperature tends toward increased evaporation. However, the compression at the same time causes a rise in pressure which acts in the opposite direction, tending to condense the fuel. Automotive research has not as yet definitely determined which of these opposing effects predominates. A primary purpose of the investigations at the U. S. Bureau of Standards is to determine the physical state of the fuel at that point in the compression stroke when the spark occurs for different operating conditions. Such determinations, however, are rendered difficult by the fact that visibility through the quartz peep holes is decreased as soot deposits, and by the likelihood of confusing fuel droplets or fog with particles of water or soot which have a similar appearance when illuminated by the arc.



The one cylinder engine is very nearly buried in the examining apparatus.

At present, industrial aviation as well as the automobile and motor boat industries are confronted with technical puzzles about fuel supply which have baffled all attempts at accurate solution. This ingenious government experimentation which fosters direct observation through glass windows of what goes on inside of the operating engine will go far in answering some of these conundrums for all time to come.

The practical aftermaths of this latest national research will be translated eventually into better and more economical engine performance and the more efficient utilization of our available supplies of fuel. Thus the progressive forward march of the air's conquest and the better standardization of flying will be expedited by these added research triumphs.

The Royal Oak Flying Club

One of the most substantially founded and progressive civilian aviation units in the country today is the Royal Oak Flying Club of Royal Oak, Michigan. This club had its inception in September, 1927, due to the efforts of Sergt. D. T. Carroll of the Royal Oak Police Department, who launched the movement to organize the club. Sergt. Carroll rented one of the local dance halls in the fall of 1927 and obtained the cooperation of newspapers in urging every airminded person to attend the initial meeting there for the purpose of organizing a flying club. Approximately 35 persons were present at the first meeting. The following week Mr. Hendry, Superintendent of Royal Oak schools, gave the club free use of a room in the High School building for its weekly gatherings. Officers were elected at the second assembly and bylaws were drawn up by which to govern the newly formed organization. A maintenance system similar to the ones employed by the British clubs was adopted by the members. Steps were immediately taken to incorporate under the Michigan State laws as a non-profit enterprise, and from its very inception the club has been self sustaining and an outstanding success in every way.

The primary object of the club is to teach the members to fly at minimum cost, but the members of the Royal Oak Flying Club feel very much indebted to the business men of their city for their assistance and encouragement when the club was in the course of formation, and they want the people of Royal Oak to feel that their club is always ready and anxious to render any service to them possible. They also feel deeply grateful to The Freese Insurance Company of Detroit for their generosity in giving them the free use of over 100 acres of land for a flying field. This field is located at the southwest corner of Maple and Crooks Roads, north of Royal Oak proper and directly east of Birmingham. The club has a Waco 10 plane, a well constructed hangar, and a spare motor for the ship.

Mr. Paul Eberle, a licensed transport pilot with about 2,000 hours, has been instructor for the club ever since the ship was delivered. He has to date soloed 8 of the members, without even a minor damage to the plane. This is a splendid tribute to his skill and judgment as an instructor.

Aerial Navigation for the Novice

By Commander Douglas G. Jeffrey
D.S.O., R.N.R., F.R.G.S.

IN a previous article, I was accused by friendly critics of being too schoolboyish and elementary even for the novice, and perhaps this criticism was justified as far as the mere unprejudiced novice is concerned. In aviation circles, however, navigation is still regarded by many pilots as a mysterious and somewhat unnecessary "frill." The scant attention that is paid to this phase of aviation in the majority of commercial schools is proof that in many quarters at least the light has not yet dawned; and there are many competent flyers who have not the foggiest ideas of navigation. Mr. Bradley Jones in a recent article stated: "With air travel an entirely new school of thought is being established. Aviation appeals to the young man, and he has not the background of deep sea navigators." The success of commercial aviation rests upon the development of trained navigators and meteorologists who will in their own element correspond to the "deep sea navigators."

I hope that in my first article I made quite clear just how compass errors were applied, and how drift could be estimated. I once prepared charts for a long overseas hop on which I laid down a great circle course and marked both true and magnetic courses in degrees alongside of the course lines. Later I adjusted the compasses of the plane that was to make the flight and handed a deviation card to the pilot, with the remark that he might if he thought it advisable apply the deviation to the magnetic course and indicate compass courses in addition to true and magnetic courses on his charts. This he proceeded to do; but applied all the errors in the wrong direction. Possibly this was the result of inadvertence. More than likely it was the result of unfamiliarity with a very simple and necessary process. Experiences like this are apt to make one overdo simplicity when writing on aerial navigation. I can't, by the way, for my own part, see the term "avigation." Most pilots, of both heavier and lighter than aircraft refer to their craft as ships, so why not stick to the term navigation, with all its tradition and background of deep sea navigators?

Before plunging any deeper into navigation I should like to make passing reference to the Titterington micrometer compensator for magnetic compasses, an illustration of which appeared in the first article of this series, and also give a brief description of two well known drift meters.

The micrometer compensator is a device that simplifies compass correction for the beginner 100%. It is in reality a reversible magnet, or to be more accurate, two permanent magnets with north poles at both ends, and south poles in the middle. Fitted over these magnets and acting as shields are adjustable soft iron sleeves capable of creating areas that will exert a north or south pull. The sleeves are controlled by two screws on the compass casing, and can be manipulated to give a "pull" of varying strength in either direction. The screws are marked thus:

E	Ø	W
N	Ø	S

All that is needed is a non-magnetic screw driver and predetermined bearings of known objects, and the fledgling should be able to "swing ship" and adjust compasses with the best of the deep sea navigators. Bear in mind that the plane should be in flying position and with motor turning over a two-thirds throttle during the swinging process.

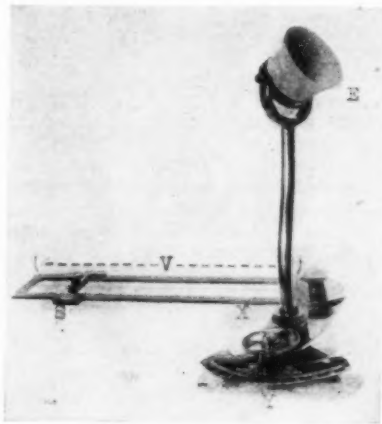


Fig. 1. An American speed and drift indicator. Eyepiece (E), vane with drift wire (V), slide with cross wire (S), fixed cross wire (X), angle of drift scale (Y).

Now for speed and drift indicators. Fig. 1 shows a well known American type, and Fig. 2 a popular British make of indicator. At present the only practical way of obtaining "drift" and ground speed, is by observation of objects on the ground, and both the above instruments are based on this principle.

The instrument shown in Fig. 1 may be mounted anywhere provided an unobstructed view downwards is obtainable (vertical if possible, but at an angle if more convenient). It is sometimes desirable to have two or more positions for mounting this instrument, so that it may be transferred quickly from one to the other, according to the direction or the drift and the convenience of the navigator. To obtain the drift angle, first make fast the support for the eyepiece in a convenient position. It is not necessary that the eyepiece be directly over the wire. The navigator then sights through the eyepiece at the drift wire and the ground below. The vane is now rotated so that the objects on the ground (or in the sea) appear to travel along the drift wire; i. e., the drift wire is placed in line with the course being made good over the ground. The drift angle, or angle between the heading of the plane and the course being made good can now be read from the scale.

To obtain the ground speed, the vane is allowed to remain in the position corresponding to the drift angle, and the slide is moved along the vane until the cross wire is at the figure corresponding to the altitude of the plane above the ground which it is flying over. Looking through the eyepiece, the distance seen on the ground is that marked on the side of the vane—either one-tenth mile, fourtenths mile, or one mile. The scale that reads "One mile for altitude in thousand feet" can also be used for "One-tenth mile for altitude in hundred feet."

With a watch the time of passage of an object from one wire to the other is noted, and reference to a table which is furnished with the instrument gives the corresponding speed in miles per hour. This instrument may be calibrated for nautical miles or kilometers, instead of statute miles; and the conversion table

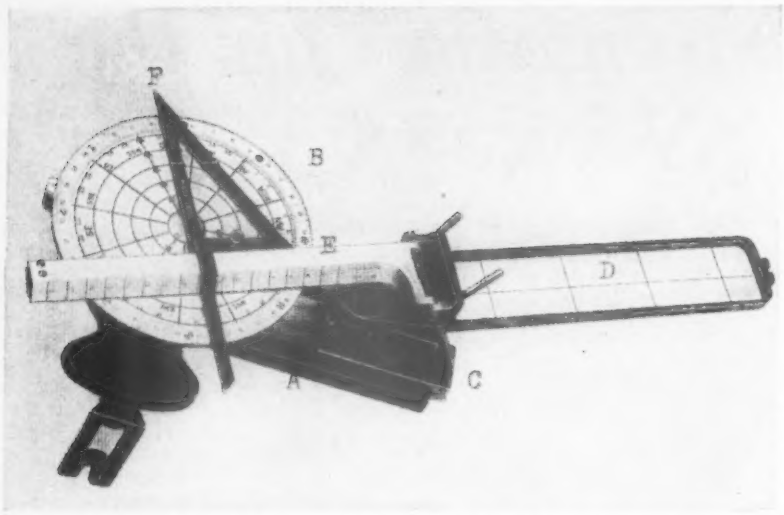


Fig. 2. A British type of speed and drift indicator. Main casting (A), bearing plate (B), fore and aft slide (C), drift frame with fore and aft cross wires (D), ruling bar with air speed and ground speed scales (E), "course made good" square (F).

furnished may also be used for any units of distance.

Fig. 2 represents a British product which is known as "Wind Gauge Bearing Plate Mark II" and which utilizes the air speed as given by the air speed indicator in a very simple manner to ascertain (a) the force and direction of the wind, and (b) the true course and speed of the machine with regard to the earth, ready for plotting on map. The instrument consists of a main casting on which is mounted a rotative divided circle and celluloid disc forming the actual bearing plate. Arrangements are provided for installing instrument in various convenient positions, but always parallel to the longitudinal axis of the plane.

A slide that works in the fore and aft line of the plane is provided; mounted on the slide are the drift frame with its wire and the ruling bar, the first forward, the latter aft, both being rigidly connected together and rotating in azimuth about a pivot secured to the slide.

The ruling bar is hinged to allow for its movement in a vertical plane and the whole is so arranged that when folded down the ruling bar rests on the bearing plate. On the ruling bar is engraved the air speed and ground speed scale, the reading marks being the center of the bearing plate (marked with a dot) and the wind point respectively. A brass square is arranged to slide along the ruling bar, the left side of which is hinged to allow folding, and this slide is engraved "Course made good."

Both the slide and the azimuth motion of the ruling bar and drift frame are fitted with clamping gear, while the bearing plate is self-clamping, being only free when pressed down. Among the advantages claimed for this instrument by the manufacturers is that it can be readily operated by heavily gloved hands.

It must be borne in mind that the best of drift and ground speed instruments are not perfect in their present stage. It is worth noting, that new ones are, however, being invented (on paper at any rate), and the navigator is in danger of being deluged with gimcrack methods, tables, diagrams and brazen instruments. Some of these are wonderful.

Heretofore we have been concerned entirely with dead reckoning, i. e., estimating a plane's position by course and speed from a well determined position. The next step is pilotage, i. e., determining a plane's position by reference to fixed objects on the earth, radio beacons, etc.

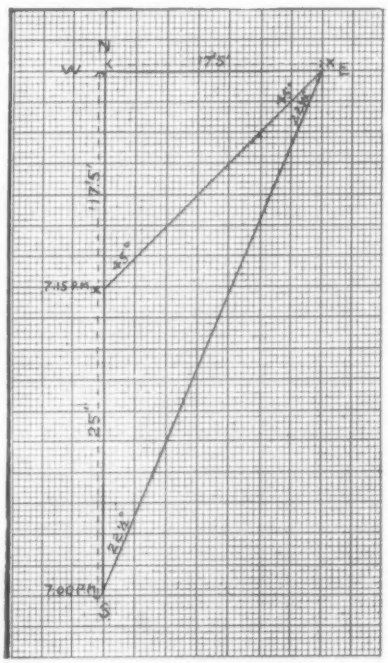
I recall reading somewhere in connection with aerial navigation a passage substantially like the following: "In practice, an experienced navigator would not actually observe with instruments the bearings and distances of objects in sight, as his judgment of position would suffice for ordinary needs." My own experience is, that it is extremely difficult to judge distances when aloft, and that on a flight of any length frequent fixes, and not mere judgments of position are essential. We must get back to Bowditch's definition which states the case about as well as it can be put: "the science generally termed navigation, which affords the knowledge necessary to enable the mariner (airman) to *determine* the position of his vessel at any time."

With the aid of an efficient magnetic compass and a drift and speed indicator, we are able to make a near approximation to ground speed; but the problem of fixing a position even under the best of weather conditions, still remains. A recent fix is invaluable if fog should come down suddenly, or if heavy rain or snow are encountered; and is of equal value whether the pilot under these conditions wishes to make a landing or desires to carry on. The failure of some of the British Navy planes to make their objective during one of the first raids on German territory (Dec. 26th, 1914), was mainly due to absence of fixes just previous to encountering fog.

The aircraft of tomorrow on long flights will provide the navigator with his own cockpit, and instruments, and a continuous chain of fixes will be the ordinary routine. Since this is the case, a brief resume of marine methods, most of which can be adapted to aerial needs, may prove of value.

A knowledge of the use of (a) bearings and (b) angles is in any case bound to be useful. The first group is to a large extent dependent on the accuracy of the estimate of ground speed and drift, and on the correctness of the compass; the second group is independent of these factors. It is not so very long ago in marine circles that what is known as "cross bearings" were a staple diet. This scheme which is worthy of our old friend Hammurabi, consists of the taking of two bearings without any particular regard to the angle. I do not propose to confuse the novice with a description of

Fig. 3. Method of determining distance from beacon when it is abeam of the plane.



obsolete methods that never had any special recommendation but will confine myself to the only two bearing methods ever likely to be of service. The "distance by four point bearing," is the exemplification of the rule, that "Whenever the angle between the course and the object is doubled, the distance run (flown) in the interval is distance off at the second bearing."

For example a plane is steering north (360) at a speed of sixty miles an hour (ground speed). At 8.0 a. m. a beacon is observed to bear N.E. (45), and at 8.06 a. m. it bears east (90). In the interval of six minutes the plane flew 10 over the ground which is accordingly the distance off the beacon when abeam (Fig. 3).

Similarly, the distance from an object when it is bearing 45 degrees abaft the beam can be had by reference to a traverse table where, under angle 45 deg., we shall find the desired information (Fig. 4). Some of the old school will remark "who is going to take traverse tables with him in a plane?" Capt. Harry Lyon, navigator of the Southern Cross on its historic flight from Oakland to Brisbane, via Honolulu and Suva, took along the following equipment (the usual navigational outfit of any well equipped ship):

Magnetic Compass
Earth Inductor Compass
Bubble Sextant
Chronometer
Altimeter
Eight-Day Clock
Stop Watch
Standard Watch
Charts and Chart Board

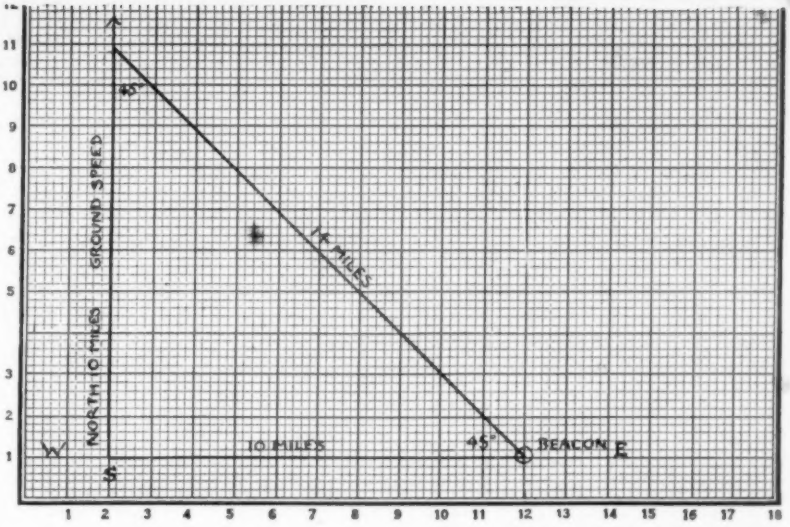


Fig. 4. Method of determining the distance from beacon when it bears 45 degrees abaft the beam of the plane.

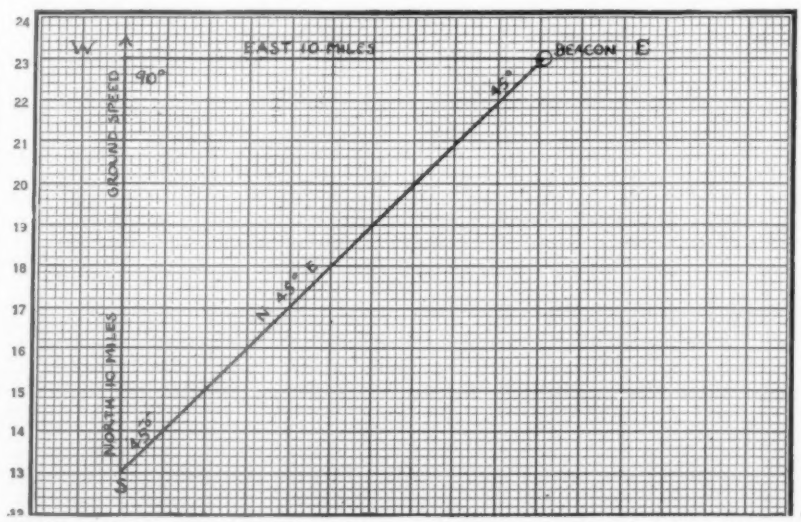
Nautical Almanac
Bowditch
Tables of simultaneous hour angles of celestial bodies H. O. Pub.: 203
Azimuth Tables of the Sun H. O. Pub.: 71
Drift Pelorous (an invention of Capt. Lyon)

I imagine the average airman who wishes to navigate can at least find room for Bowditch.

Critics of the "four point" method have said with truth, that it is defective, in that the navigator sometimes wishes to know the distance that he is going to pass off an object before it is abeam. We can solve this difficulty however, without deserting the four point method.

Let a plane be steering north at 100 miles per hour ground speed, the intention being to pass a few miles to the west of a beacon X. In time X is sighted a little to starboard. At 7.0 p. m. when bearing N. N. E. (22½°) the time is noted. At 7.15 p. m. X bore N. E. (45) and the plane had flown 25 miles over the ground (Fig. 5).

Fig. 5. The four point method of determining the distance of an object before it is abeam.



The first bearing has been doubled and the distance flown in the interval is the distance off at the second bearing, namely 25 miles. This distance multiplied by .71 gives the distance that X will be off when abeam. Here are the figures $.71 \times 25' = 17.75'$ miles.

In practice reject the second decimal and multiply by .7. If you want to know where .71 comes from look up the traverse table at 45° and against 1 in the distance table you will find it. It is merely a question of the proportion of the sides of a triangle. This I believe to be the best of the bearing methods and it can be solved mentally. It may happen that X may not have been visible until nearly abeam. In this case the bearing is on 26½° before the beam and again when it has the same bearing abaft the beam and the distance flown in the interval is the distance off when X was abeam. These bearings form very nearly an equilateral triangle and hence give good results.

Should a bearing before or abaft the beam be observed at any angle on the bow or quarter, the distance when abeam can be obtained by multiplying the distance flown (over the ground) in the interval by a factor from the table, Fig. 5a (Capt. S. T. S. Lecky).

The compass in a plane is rarely in a good position for taking observations, and a pelorous, or bearing plate, is frequently used for this purpose. The

39	.81	45	1.00	51	1.23	57	1.54	63	1.96	69	2.61
40	.84	46	1.04	52	1.28	58	1.60	64	2.05	70	2.75
41	.87	47	1.07	53	1.33	59	1.66	65	2.14	71	2.90
42	.90	48	1.11	54	1.38	60	1.73	66	2.25	72	3.08
43	.93	49	1.15	55	1.43	61	1.80	67	2.36	73	3.27
44	.97	50	1.19	56	1.48	62	1.88	68	2.48	74	3.49

Fig. 5a. Table of factors for the four point method as worked out by Capt. Lecky.

pelorous originally invented by Lieut. Friend, R. N., whose patent rights have long since expired, consists of a dummy compass card entirely unmagnetic and in no way partaking of the character of a compass, except that its face shows points and degrees in the usual way. This card, which may be made of any suitable metal, revolves on a pivot and is fitted with sights that can be revolved independently or clamped to it. A line parallel to the fore and aft line of the plane on the inner ring does duty as a lubber line and a screw on the fore part allows the card to be clamped to any desired course. A pelorous can be placed in practically any convenient position, and can readily be moved from one position to another.

So much for position by bearings. Now for position by angles; what is known as the three point problem has never as far as I know been written up from an aviation point of view, though why I do not know. Two angles can be taken more quickly than two bearings. In fact with a double sextant, two angles can be taken simultaneously. Position by angles will before long be an acknowledged part of aerial navigation, and so we may as well consider a few simple examples.

For the efficient use of angles we require a double sextant and a station pointer, neither of which is a very bulky article and both of which are manufactured of light weight materials. If angles are taken and applied correctly the only error that can creep in is inaccuracy in chart or map. The three point problem is based on Euclid IV.5: "through any three points not in a straight line, a complete circle can always be drawn, and but one." For the reader that prefers a detailed analysis, here it is:

Let the unknown angle at A be x and the angle at B be y. Then x and y may be found, as follows, by the algebraical artifice of the employment of an auxiliary angle, here called Ø. In any plane triangle we have sides proportional to the sides of the opposite angles, as proved in plane trigonometry. Hence, in the triangles A. P. C. and B. P. C., it follows that:

$$\frac{\sin. x}{\sin. M} = \frac{CP}{AC} \quad (1) \qquad \text{and} \qquad \frac{\sin. y}{\sin. N} = \frac{CP}{BC} \quad (2)$$

$$\therefore \quad CP = \frac{AC \sin. x}{\sin. M} \quad (1)$$

and

$$CP = \frac{BC \sin. y}{\sin. N} \quad (2)$$

but things that are equal to the same thing are equal to each other:

$$\therefore \quad \frac{AC \sin. x}{\sin. M} = \frac{BC \sin. y}{\sin. N}$$

and

$$\therefore \quad \frac{\sin. x}{\sin. y} = \frac{BC \sin. M}{AC \sin. N}$$

and the right hand of this last equation may be assumed correctly to be equal to a tangent of the auxiliary angle, because the tangent of an angle varies through every value from zero to infinity, plus or minus

$$\therefore \quad \frac{\sin. x}{\sin. y} = \frac{BC \sin. M}{AC \sin. N} = \tan. Ø$$

Then by subtracting and adding unity to each side of this equation, and dividing out, we get:

$$\frac{\sin. x - \sin. y}{\sin. x + \sin. y} = \frac{\tan. - 1}{\tan. + 1}$$

Reference to plane trigonometry shows that this equation may be written in a more convenient form for logarithmic calculation:

$$\frac{\tan. \tfrac{1}{2}(x - y)}{\tan. \tfrac{1}{2}(x + y)} = \tan. (Ø - 45°)$$

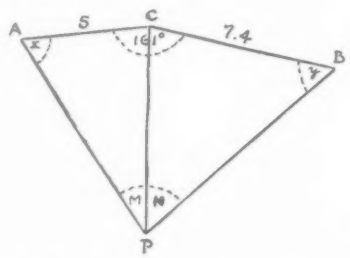


Fig. 6. The three point problem.

The auxiliary angle artifice is often handy. Here it obtains a direct solution of the three point problem, and the same formula covers every case.

Let M=34°, N=48°, ACB=161°. AC=5′, BC=7.4′, to correspond to Fig. 6, and the solution is indicated below, first finding the value of Ø and then ½(x—y). It will be noticed that (x+y) =360° (M+N+ABC)=360°—243°= 117°; and therefore, ½(x+y)=58° 30′. P is the plane's position sought.

7.4	log.	.86923 (Ø—45) tan.	8.73132
34	sin.	9.74756 ½(x+y) tan.	0.21268
48	cosec.	0.12893	
		½(x—y) tan.	8.94400
		0.74572	
5	log.	.69897	
Ø	tan.	.04675	

$$\therefore \quad Ø = 48° 05' \qquad x - y = 10°$$

$$x + y = 117°$$

$$x = 63° 30'$$

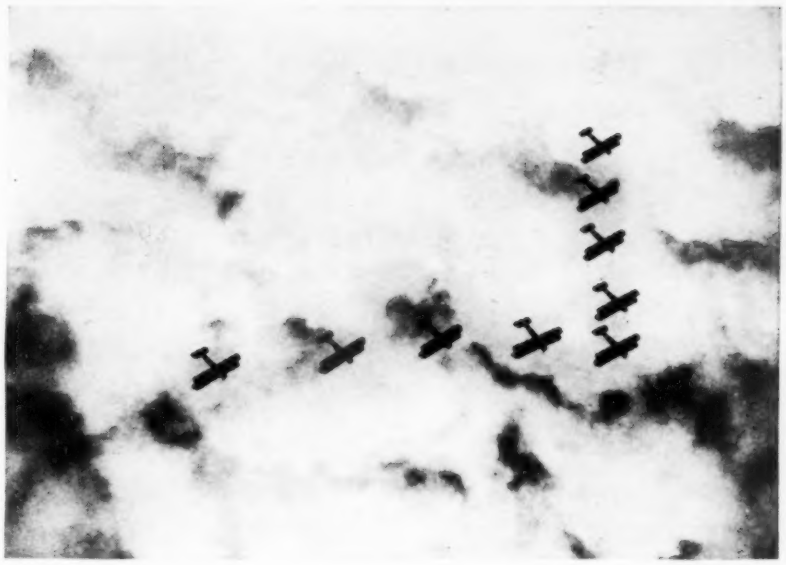
$$y = 53° 30'$$

The double sextant and the station pointer give a mechanical solution of the above. The station pointer is merely a three-legged protractor and a double sextant is self-descriptive. We have, however, an instrument that combines the two, namely the double reflecting goniograph which not only permits of two angles being observed simultaneously, but can also be used for the actual plotting on the chart. The goniograph is held in the hand like an ordinary sextant and as soon as the angles are taken, the handle is "unshipped" and the instrument is placed on the chart or map in the same way as a station pointer or protractor. Angles can be taken much more quickly and much more accurately than bearings. If the objects are distant, a trifling error in a bearing will materially affect the resulting position; while an error in the angle can scarcely amount to a tenth part of a degree. Again deviation changes with the direction of the plane's head and here arises another possibility of error, that of applying the error the wrong way—a thing that may easily happen in a moment of hurry or excitement. Further, the compass may not be in a handy position or the plane may be yawing at the critical moment. The following limitation must, however, also be borne in mind. The problem becomes indeterminate when the three points observed and the observer's position all fall on the same circle or approximate thereto, the acute angles in the latter case magnifying small errors in observation into large errors in position. So much for the virtues of the angles.

It is fully realized that bearings and angles are not likely to become part of the routine of the pilot on short flights made, say at 2,500 to 5,000 feet in fine weather and over known and well marked territory; but right here in "God's Country" there are wide stretches of territory which are wilderness as far as distinctive markings are concerned and to the pilot crossing these areas bearings and angles might often prove a solace at dusk, with a dirty night ahead, or when approaching fog or rain, or at

(*Continued on page* 94)

Another Dodo Speaks



An open V formation against a threatening sky.

"DODO Days." What are Dodo Days? One long year of thrills, joys, sorrows, worries and, most of all, good old hard work. I enjoyed Cadet Dodo's articles in POPULAR AVIATION AND AERONAUTICS some months ago immensely and was greatly disappointed when he washed out, because this meant a discontinuance of his story. Perhaps my interest can be attributed to the fact that I am a Dodo myself—the only difference being that I have gone further than he was able to go. Through some unforeseen "grace of the gods," I have passed my final check-off of DeHavillands and am now waiting to be transferred to Kelly—a matter of a few more days. Allow me to take up the story where Cadet Dodo has left off, due to his misfortune, a misfortune that befalls fully fifty per cent of all who seek the ever-vanishing Wings. It is no disgrace to wash-out. We have all decided that, and as a result go into each day's work with this in mind.

Have you ever read Edgar Allan Poe's "Eldorado"? I often think of this in connection with the struggle for Wings. To quote:

"Over the mountain of the moon,
Down the valley of the shadow."
"Ride, boldly ride, the shade replied,
If you would seek for Eldorado."

A few fortunates find Eldorado in the shape of boots and Sam Browns, while the others fall by the wayside, wiser in what they have learned, but heart-broken in what they have failed to gain.

Cadet Dodo has painted a vivid picture for his readers: a picture of one who has washed out. There is not a cadet who has not passed through this period of anxiety which Cadet Dodo went through unsuccessfully. His account of taking his final checks brings a sympathetic smile to my face. Please let him remember this—anyone who can fly for an instructor can fly for a check pilot, because that is all a check pilot is. He expects no more of a student than that student's instructor expects of him. Doesn't this sound logical? All flyers in the army, as far as training goes, are practically equal. Everyone learns under the same system, so why should one man expect something that the next does not? A washout check does not always mean a washout, as has been proved by at least a half dozen cases in my own class. One flies on merit and merit alone—the check pilot is "unbiased and unbossed"; that is the reason for his being a check pilot.

To be sure, I sympathize with him—more than I can express—but I cannot help thinking that he has slightly exaggerated matters, not through any fault of his own, but due to his inexperience. He suffered pangs of regret that everyone who has gone through the school has suffered, but he lacked a few more months of training that would have served to mellow his conclusions. At one stage of the game I dreamed of being washed out. I even had my story composed for the "Benzine Board." I sent frantic S. O. S.'s home seeking some political pull. In short, I did exactly what I should not have done—I let my imagination run riot. I was not alone in this. At the close of each day I would check the calendar and mutter, "Another day!" We all lived days. Now that that period has passed we can all afford to smile at our worries, but, just the same, they were vivid enough. Truth to tell, this demonstrated that Cadet Dodo was not wrong in saying that the mental strain is great. This has since been corrected and I will deal with this later. It also indicates, however, that any student who allows a quick-tempered instructor to get through his "hide" and who blows up while riding with him would scarcely come through in a tight pinch should it occur while he is soloing. This seems to be a part of the system—to weed out the nervous ones.

During my eight months' stay here I have attempted to classify cadets into four divisions. I may not be entirely right in this, but I do believe my conclusions would serve as a crude summary for those knowing nothing about flying or the army system. It might explain why one man is successful and the next unsuccessful. First, there are the "hot" ones; those that take to flying like ducks to water. Second, the average, who learn slowly but who practice every moment that they are in the air. Third, the "indifferents"; those who could learn but make no honest effort to do so. Fourth, and last, those who do not possess inherent flying ability and cannot possibly learn army maneuvers.

The first have no difficulty getting through. Apparently they are the favorites and their instructors place unlimited confidence in them. The second, as a rule, make the grade. They take their work seriously, practice eights, climbing turns, rolls, and all maneuvers until the perspiration rolls off their faces and they are wringing wet when their morning's activity has ceased. They regard flying in the same light that a golfer regards his game—practice makes perfect. The third, the "indifferents," take joy rides when they should be working. Gradually they lag behind until they are hopelessly lost from the rest of the class. Fourth, and last, the "non-flyers," are mostly willing workers but they lack the "gift," just as one who does not have the touch of all musical instruments or an

An open V formation at an altitude of 1,000 feet.

ear for music cannot possibly hope to learn to play. The army considers that it is doing this last group a favor by sending them home. Statistics have shown this type of man is a legitimate prey for the "grim reaper."

At the present time conditions are such in the training centers that the army has not the time, equipment, money nor officers to devote a fifty-hour training schedule to those who are slow in learning. I'll admit that to the boy who would like to get his commercial license this would be a great help in getting started, but the facilities are not available for doing this. The army is primarily interested in turning out military pilots and a solid year is needed to do this. Peace time is the one and only time that the army can and will develop excellent pilots without sacrifice of quality. Isn't this as it should be—to make our Air Corps the most thoroughly trained and the best in the world?

Starting last July first a new system of training was inaugurated. The question arose as to whether or not the great number of washouts was justified. By using their high entrance requirements it was a certainty that the government schools were getting the best material available. At last some attempt was made to enlarge the graduating classes. The old method of having stages and a new instructor for each stage was abolished; stages were wiped out and a student now keeps the same instructor all the way through. This eliminates to a great degree the mental hazard that the cadet has been forced to hurdle. It also takes the fear of the check pilot out of his system because now he seldom rides with one. His own instructor serves a dual capacity day by day. This method has proved itself better in that sixty per cent more students are graduating from our class than graduated from the class preceding. It should increase the number of graduates in the following class, as they are enjoying, and I say "enjoying" in every sense of the word, the system through the entire school, from P.'s through D. H.'s. I make no wonderful claims for it, but it is decidedly better than the old system and it does prove that steps are being taken to increase the number of graduates without decreasing the quality of each graduate.

In closing, let me add that the cold-blooded manner of washing a man out does seem harsh, on the face of it, to the average taxpayer. This is the natural reaction. Let us go a little further. Flying in the army does not merely consist of flying alone. If it did, matters would be simplified and there could be few washouts. Army flying consists of flying together, of formation flying, and one's life really rests in the hands of the other fellow. Fly a large formation and place someone in the middle of it who is nervous, excitable, and not sure of himself and you are endangering the life of everyone in that formation. You at least make everyone in it uncomfortable and create a poor formation. One cannot divide his attentions between the man ahead and the man behind while skimming through the sky in tight formation at 100 miles an hour. It is one's job to keep one's allotted distance from the man ahead and pray to his Almighty that the man behind does not come gliding into collision on a turn.

This has proved to be more of an explanation written in the defense of the army than an account of Dodo Days. I find that there were some points in Cadet Dodo's last article with which I could not quite agree. It is at least a view of the training system as seen by a cadet while going through the course and to this end it may prove valuable. Please remember that the army is the greatest experimental laboratory as well as the greatest training institution in the world. If the system is wrong now, and I sincerely believe that it is not, the reader may rest assured that eventually, through trial and error methods, the system will be corrected.

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Survey of Aeronautical Stocks

By R. D. Small
General Manager, Aviation Financing and Trading

THE paramount financial event in the United States in the last 30 days was the application of the Federal Reserve policy of restricting credit connected with the purchasing of securities, which caused an unusually severe decline in the values of almost all securities listed on the various exchanges and curbs of the United States.

That some corrective measure was justified no one questions, but the manner of application has been severely criticized in many quarters.

The Wall Street Journal states in a recent number: "The business and financial communities have a just grievance in the attitude of smug silence taken by the Directors of the New York Reserve Bank, following the five-hour meeting of last Thursday, and in only less degree before and after that affair by the Reserve Board in Washington. . . . At the end of Thursday's protracted meeting the directors of the New York bank confined their utterances to a cryptic 'No announcement,' and that from a minor officer. The legitimate efforts of the press to obtain some useful light upon proceedings, or even a direct answer to the question whether the discount rate had been changed, inevitably arousing the keenest public interest, were completely blocked. If officers of a large private corporation were to adopt this complacent Bourbonism today they could not long hold their jobs. Our central banking authorities are in fact falling below the standard of regard for informed public opinion set by such companies as United States Steel, General Motors, and American Telephone."

After the application of the corrective measures the general market seems to have steadied, though with a much restricted volume. In this connection it might profitably be observed by all holders of securities that fundamental business conditions throughout the country appear, with but very few exceptions, to be unusually sound and anyone who sacrifices his investments and sells solely because of the recent "rebuke" from the Federal Reserve authorities will probably have serious regrets later in the year. Many of the brokerage houses who have seen a curtailment in the total sales on the New York exchange down to around 3,000,000 believe that this state of affairs will only persist for a comparatively short period, although it is recognized that time money is still high

In this last market slump attributed to the Federal Reserve credit attitude, 25 of the leading Industrials showed an average decline of 21 points and 20 leading railway stocks 11 points. During the same period the 20 most active aeronautical stocks on the New York Curb showed an average decline of 2 points. The strength and resisting power of the aeronautical securities in both this and the December break is claiming the attention of many investors.

The two dominating units in the aeronautical field are the so-called Curtiss-Keys interests, and the United Aircraft and Transport Company. The former represents a well-rounded organization, which includes production, transportation, banking, and distributing units. Both it and the United Aircraft and Transport are self-contained, well managed and amply financed, and so are entitled to the most serious consideration of the intending investor. At the time of issue the market value of the securities of the parent Curtiss Company, with its various subsidiaries, including Transcontinental Air Transport, National Aviation, North American Aviation, Credit Corporation, Aviation Securities, Curtiss Flying Service, Curtiss-Reid Manufacturing, Curtiss Export, and Curtiss Robertson, and National Air Transport, was $72,754,048. The indicated market value on February 5th was $183,564,950, or over 150%. The largest appreciations were National Air Transport from $2,000,000 to $13,500,000; National Aviation from $3,525,000 to $10,500,000, and Transcontinental Air Transport from $6,250,000 to $13,250,000, Sikorsky from $2,500,000 to $8,000,000, and Curtiss Flying Service from $9,375,000 to $18,375,000. All of the above companies have been financed within the past twelve months.

The United Aircraft and Transport presents a very satisfactory picture. It comprehends one of the best managed transport companies in the world, and one of the two leading engine manufacturers in the United States, an accessory manufacturer, and three concerns manufacturing airplanes, one of which is admittedly amongst the best three manufacturers in the country, and with the largest bank in the United States sponsor for the consolidation. The aggregated earnings of this group in 1928 was estimated to be $4,600,000, of which it is interesting to note that $2,000,000 were accredited to Pratt & Whitney Aircraft Company, makers of the Wasp and Hornet, and other engines—thus indicating that the earning capacity of a good engine manufacturer outreaches apparently that of any other branch in this industry, as presently operated. Annual earnings at the rate of the last quarter would be $6,900,000.

The stocks of the United Aircraft and Transport are quoted on the New York Curb, and it is reported will be shortly listed on the New York Exchange. Market at this writing is 76 for the preferred, and 90½ for the common. Farseeing investors are recognizing the attractiveness of the preferred, as it carries a warrant good until November 1, 1938, giving the holder of each two shares the right to purchase one share of common stock at $30 a share. The preferred has a par of $50, and carries an accumulative dividend rate of 6%. As the common is now selling above 90 the warrant appears to have a very real value. Present market values of the preferred and common are in excess of $156,000,000, making this company the largest unit in the aeronautical world.

There are rumors to the effect that Western Air Express will probably be consolidated with the above company, although we are inclined to believe that the chances are against this taking place. Western Air showed in 1928 a net income of $720,000, after depreciation, or at the rate of $6.73 per share on the 107,075 shares of stock. The company's operating revenue was $1,386,000, of which mail carrying amounted to $1,208,000, the balance being secured through passenger service.

The stockholding corporations, such as National Aviation, Aviation Securities, North American Aviation Corporation, Aeronautical Industries, Air Investors, etc., have been increasingly attractive to the investors in aeronautical stocks. Almost all of them have shown an unusual earning capacity. Aviation Securities Corporation in its holdings of just one security has an appreciation of around $750,000 and it is reported that additional increases in other securities marked up its paper profits to around $1,000,000. This has been accomplished in the last three months. Within the last thirty days a disposition has been observed in some quarters to exchange National Aviation for the latter stock. The reasons given by some who have made this transfer were, that the two companies had quite a few of the same securities in their portfolios, that Avia-

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Elements of Performance Calculation

IN our last article, we presented the characteristics of a typical wing, the Clark Y, a section of excellent aerodynamic properties. There is no "best" wing known to designers; there are a large number of good wings to select from, and there is always some wing best fitted for a particular design. The student may be anxious to learn of good wings other than the Clark Y, and to approach the interesting subject of wing selection. It is better, however, to study first of all the simple, theoretical elements of airplane performance, which serve largely as a basis for wing selection.

Wing Horse-Power

In our first article we defined work as force × distance. The term horse-power was defined as the rate of work done in a given period of time, 550 foot-pounds per second, 33,000 foot-pounds per minute. In airplane work, the force is expressed in pounds, the speed in miles per hour. This introduces a difficulty which can, however, be easily surmounted.

Suppose the drag of an airplane wing is D_w pounds, and the speed is V miles per hour. The speed in feet per second is then

$$\frac{V \times 5280}{60 \times 60} = \frac{V \times 5280}{3600}$$

The work per second in overcoming the drag of the wing is therefore

$$\frac{D_w \times V \times 5280}{3600}.$$

Since horse-power is is 550 foot-pounds per second, the horse-power required is therefore

$$\frac{D_w \times V \times 5280}{3600} \times \frac{1}{550}$$

which cancels out to $\frac{D_w V}{375}$.

We have thus derived the important formula

$$P_w = \frac{D_w V}{375}$$

where P_w is the power required by the wing

D_w is the drag of the wing in pounds

and V is the speed in miles per hour.

It is sometimes convenient to use an alternative form introducing the drag coefficient of the wing, and its area.

$$D_w = K_x A V^2$$

Substituting in the previous equation, we get

$$P_w = \frac{D_w V}{375} = \frac{(K_x A V^2) V}{375} = \frac{K_x A V^3}{375}$$

There is another convenient formula for the wing horse-power, based on the fact that the drag of the wing $D_w = \frac{W}{L/D_w}$

where W = weight of the airplane and L/D_w is the efficiency ratio of the wing.

Hence $P_w = \frac{D_w V}{375} = \frac{W}{L/D_w} \times \frac{V}{375}$

Characteristics of Clark Y in Tabular Form

In the last article we presented some curves for Clark Y characteristics. Sometimes it is handy to have them in tabulated form as follows:

Angle of Attack in Degrees	K_y	K_x	L/D
−6	−.0001	.000041	−2.44
−4	.0003	.000039	7.7
−2	.00068	.000040	17.0
0	.00105	.000051	20.6
2	.00140	.000070	20.0
4	.00178	.000100	17.8
6	.00214	.000132	16.2
8	.00251	.000173	14.5
10	.00276	.000219	12.6
12	.00301	.000268	11.22
14	.00320	.000323	9.92
16	.00300	.000431	6.96

Example

A monoplane of 200 square foot wing area, Clark Y wing section, carries a load of 1600 pounds. What are the speed, wing drag and wing horse-power when flying at 2 degree angle of incidence?

At 2 deg. $K_y = .00140$, $K_x = .000070$.

$$V = \frac{W}{K_y A} = \sqrt{\frac{1600}{.00140 \times 200}} = 76 \text{ m.p.h.}$$

$D_w = K_x A V^2 = .000070 \times 200 \times 76^2 = 81$ pounds.

$$P_w = \frac{D_w V}{375} = \frac{81 \times 76}{375} = 16.42 \text{ horse-power}$$

Curves of Wing Drag and Wing Horse-Power

When curves of wing drag and wing horse-power are required through the flying range, calculations are tabulated as shown in the table below (these apply to the monoplane just described).

The curves of wing drag and wing horse-power are plotted in Fig. 1 against the speed in miles per hour. The angles of incidence are also indicated on these curves, as a matter of general interest.

From these curves a number of interesting points are apparent:

1. As the angle of incidence goes to a negative value and the K_y becomes very small, the velocity becomes very great. If we could fly an infinitely small K_y, the velocity would become infinitely great. Of course this is a purely theoretical conception, because there would not be sufficient horse-power to fly at tremendously high speed.

2. There is a definite minimum speed corresponding to the angle of maximum K_y. Beyond this angle the speed increases again.

3. The least wing drag occurs at about 80 miles per hour, at an angle of incidence of about zero degrees. This is the angle of best or maximum L/D. We might have expected this since $D_w = \frac{W}{L/D_w}$

4. Below the speed of best L/D, the wing drag increases fairly slowly up to the "stalling" speed. Beyond the stall, the speed increases. The efficiency of the wing drops off and the wing drag rises very sharply.

5. In studying the curves of wing horse-power, we notice that the minimum horse-power occurs at a lower speed and a larger

Speed M.P.H.	V^2	$K_y = \frac{W}{AV^2}$	i = Angle of Incidence	K_x from Tables or Curves	$DW = K_x \cdot AV^2$	$P_w = \frac{DW}{375}$
60	3600	.00222	6.2°	.000143	100.1	16
70	4900	.00163	3.3°	.0000820	80.2	15
80	6400	.00125	1.1°	.0000588	75.2	16
90	8100	.00099	−0.25°	.0000494	80.0	19.2
100	10000	.00008	−5.20°	.0000445	89.1	23.8

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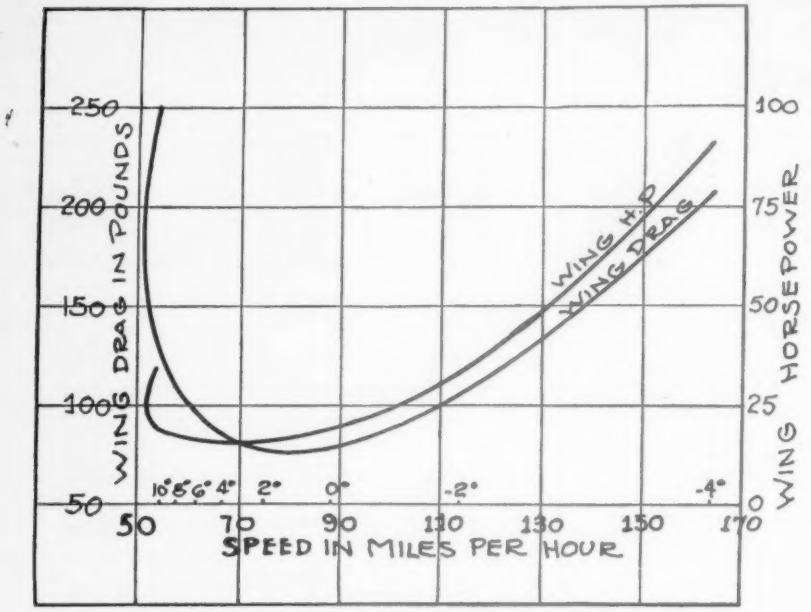

Fig. 1. Curves of wing drag and wing horse-power against speed in m. p. h.

angle of incidence than the point of minimum drag, namely at 70 miles per hour and approximately 3 degrees incidence.

6. At small angles and high speeds the wing horse-power increases rapidly since efficiency goes down as speed goes up. It also increases rapidly at stalling speeds, where the curve bends back on itself.

Parasite Drag and Parasite Horse-Power

The parasite drag of an airplane is the drag of all its parts other than the wing—the drag of the fuselage, landing gear, struts, wires, etc.

The parasite drag may be denoted by the symbol D, and we can write

$$D = K_p V^2$$

where D = parasite drag of the airplane in pounds

K_p = parasite drag coefficient in pounds per mile per hour.

V = speed in miles per hour.

The parasite drag coefficient of an airplane changes much less markedly with the attitude of the airplane, than the drag coefficient of the wing. For example, it is evident that the drag of the landing wheels will depend solely on the speed and not on the flying attitude of the airplane. Diehl in his "Engineering Aerodynamics" classifies the following items as having drag coefficients independent of the angle of attack of the wings: "struts, wires, fittings, wheels, tail skids, ordnance equipment, air-cooled engines, radiators, and fuselages having circular or elliptical cross-sections." Such items as floats, hulls, tail surfaces, and fuselages of square or rectangular section vary in drag coefficient with angle of attack.

The increase in the parasite drag coefficient is, however, most marked at high angles of incidence and slow speed, when both drag and horse-power required become less important to us. Therefore in estimating performance, the parasite drag coefficient is very often considered to be a constant.

It is sometimes convenient to refer the parasite drag coefficient to the wing area.

The equation for D_p then becomes

$$D_p = K_p V^2 = K_p A V^2$$

where K_p parasite drag coefficient in pounds per square foot of wing area per mile per hour $= \frac{K_p}{A}$

The equation for parasite horse-power becomes

$$P_p = \frac{D_p V}{375} = \frac{K_p \cdot V^2 \cdot V}{375} = K_p V^3$$

or $$P_p = \frac{D_p V}{375} = \frac{K_p A V^2 \cdot V}{375} = \frac{K_p A V^3}{375}$$

The equation for total drag becomes

$$D_t = D_w + D_p = (K_x + K_p) A V^2$$

and the equation for total power becomes

$$P_t = P_w + P_p = \frac{(K_x + K_p) A V^3}{375}$$

In estimating the parasite drag of an airplane, the drag coefficient of each part has to be found, and all these values added together. Errors are introduced because of interference between parts. The resistance of wheels and landing gear struts tested together in the wind tunnel may be greater than the sum of the resistance of the same wheels and struts tested separately, because at the point where struts and wheels adjoin, there may be constriction of the air flow. The parasite drag is therefore frequently estimated from the test of a complete tunnel model, by subtracting the wing drag from the total drag of the model. Sometimes the parasite drag is obtained in similar fashion from a full flight test.

Total Drag and Total Horse-Power

The formula for total drag of the airplane is evidently:

Total drag, D_t = wing drag + parasite drag

$$= D_w + D_p = K_x \cdot AV^2 + K_p \cdot AV^2 = (K_x + K_p)\ AV^2$$

Similarly the formula for total horse-power required becomes

P_t = wing horse-power + parasite horse-power

$$= P_w + P_p$$

$$\frac{K_x\ AV^3}{375} + \frac{K_p\ AV^3}{375} = \frac{(K_x + K)\ AV^3}{375}$$

Example

The monoplane previously mentioned of 200 square feet wing area, Clark Y wing, 1,600 pounds gross weight, is found on test to have a maximum speed of 130 miles per hour and is equipped with a 110 horse-power engine. If the efficiency of the propeller is 80% at maximum speed, what are

(a) parasite horse-power at 130 miles per hour?

(b) parasite drag at 130 miles per hour?

(c) parasite drag coefficient?

(d) parasite drag coefficient referred to wing area?

(a) At top speed, the efficiency of the propeller is 80%, therefore the power delivered to the airplane is

$$\frac{110 \times 80}{100} = 88 \text{ horse-power.}$$

The wing horse-power at top speed is 50 horse-power.

Therefore the parasite horse-power is $88 - 50 = 38$ horse-power.

(b) Parasite horse-power $P_p = \frac{DV}{375}$

$$\text{or } 38 = \frac{D_p\ 130}{375}$$

So that parasite drag $= \frac{38 \times 375}{130} = 109.5$

(c) $D_p = K_p V^2$

$109.5 = K_p\ (130)^2$

and $K_p = \frac{109.5}{130^2} = .0065$

(d) $K_p = \frac{K_p}{A} = \frac{.0065}{200} = .0000325$

(*Continued on page 46*)

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Curves of Parasite Drag and Parasite Horse-Power

When once the parasite resistance coefficient is known and provided it is assumed to remain constant with angle of attack, it is easy to calculate for every speed the parasite drag from the formula

$$D_p = K_p V^2$$

and the parasite horse-power from the formula

$$P_p = \frac{K_p V^3}{375}$$

From these curves it is evident that at low speeds, the parasite drag is much less than the wing drag, and the parasite drag much less than the wing horse-power. At high speeds the inequality diminishes. From this we deduce that for fast machines "cleanness" of design is more important than for slow machines.

Curves of Total Drag and Total Horse-Power

In Fig. 2 these curves have been compounded to give curves of total drag and total horse-power.

The minimum total drag is about 112.5 pounds and occurs at 2 degrees, a somewhat higher value than the minimum drag point of the wing alone. (We shall explain this in a later article.) Neglecting considerations of engine speed and propeller efficiency, this point would give the condition for the least work in flying a given distance, since work = force × distance. In trying for a distance record with a given quantity of gasoline, the pilot would theoretically fly at this angle of incidence of two degrees.

The minimum total horse-power is about 20 and occurs at about 4 degrees, again a somewhat higher value than the minimum horse-power point of the wing alone. Again neglecting considerations of engine and propeller, this would be the correct point to fly at for maximum endurance in time, as distinct from maximum endurance in distance. We shall see later the point of minimum horse-power is the point of best climb, but it is *not* the point of maximum efficiency.

Direct Calculation of Total Drag and Total Horse-Power

For purposes of instruction, we calculated the curves of wing drag and horse-power separately from the curves of parasite drag and parasite horse-power. But if the parasite resistance coefficient is known, all the curves can be made in one table as follows:

Speed V M.P.H.	V^2	$K_y = \frac{W}{AV^2}$	K_x from Tables or Curves	K_p	Total Drag $D_t = (K_x + K_p) AV^2$	Total H.P. $P_t = \frac{D_t}{375}$
60	3600	.00222	.000143	.0000325	124.2	19.85
70	4900	.00163	.000082	.0000325	112.1	20.95
80	6400	.00125	.0000588	.0000325	116.8	24.90
90	8100	.00099	.0000494	.0000325	132.6	31.80
100	10000	.00008	.0000445	.0000325	154.0	41.15
etc.						

Curve of Horse-Power Available

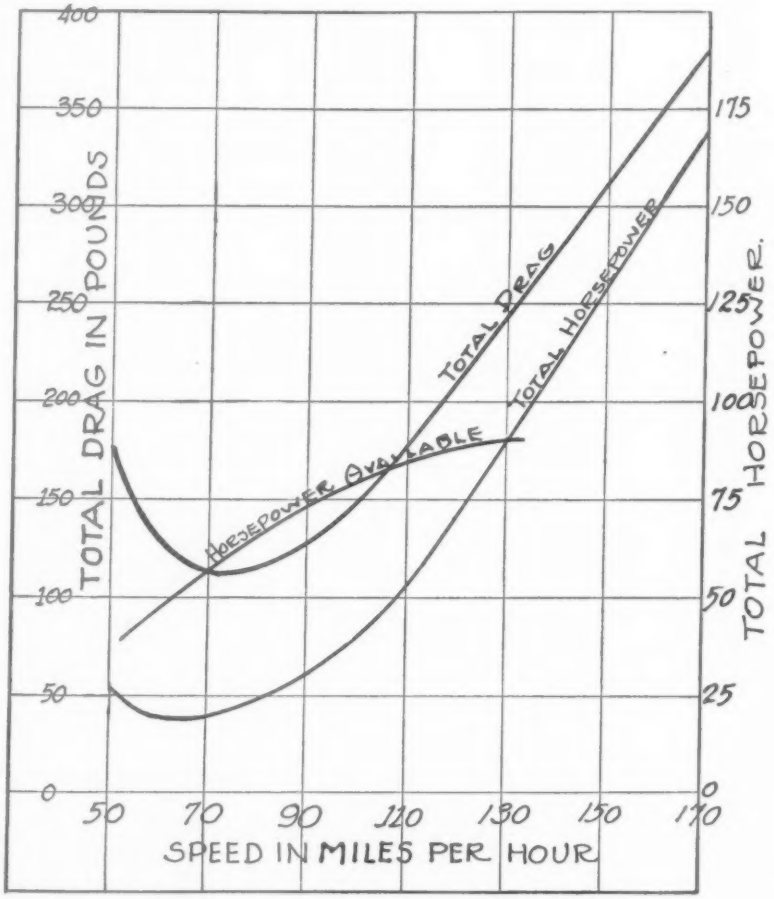
The horse-power available is found by multiplying the horse-power of the engine by the efficiency of the propeller. Since the engine speed falls off at lower plane speeds, and the efficiency of the propeller varies with the ratio of forward speed to revolutions per minute, calculating the horse-power available curve is quite a difficult matter which we shall leave to a later chapter. The curve of horse-power available shown in Fig. 2 is merely what an experienced calculator would expect from an engine of 110 horse-power, with a propeller efficiency of 80% at the top speed of 130 miles per hour.

It is because this curve of power available crosses the total power required curve at 130 m.p.h. that we know this speed to be the top speed.

We see that at lower speeds, with engine all out; the power available is in excess of the power required. For equilibrium the difference must be taken up in climb.

In climb, the excess horse-power goes into doing work against gravity. For example, at 90 miles per hour the excess horse-power is 42.5, or 42.5×33,000 foot pounds per minute. Since the weight of

Fig. 2. Curves of total drag and total horsepower.



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the airplane is 1,600 pounds, the climb in feet per minute is

$$\frac{42.5\times 33{,}000}{1600}=877 \text{ feet per minute.}$$

Inspection of the curves indicates that the maximum excess horse-power occurs at about 80 miles per hour, when the power required has approximately its minimum value.

It is a noteworthy fact that for our curves, and in the case of most modern machines, there is excess horse-power at the minimum speed of the plane. Excess power at minimum speed provides a measure of safety against "stalling," since the pilot can then pull his plane out of the stall by letting out the engine and beginning to climb.

Equivalent Flat Plate Area

For purposes of comparison the parasite resistance is sometimes expressed in terms of the equivalent flat plate area. In the monoplane described in the previous problem, what will be the equivalent flat plate area?

The parasite drag at 130 m.p.h. was 109.5 pounds.

Let A_e be the equivalent flat plate area, whose resistance coefficient is .0032. Then

$.0032\times A_e\times 130^2=109.5=K_p\times 130^2$

and $A_e=203$ square feet,

which is a very low figure, and shows that our monoplane is extremely well streamlined.

The same result would be obtained by writing $A_e=\frac{K_p}{.0032}=\frac{.0065}{.0032}=2.03$

We shall often compare machines on the basis of their equivalent flat plate areas.

Overall Efficiency of an Airplane

The overall efficiency is given by the expression

$$\frac{W}{D_t}=\frac{K_y\,AV^2}{(K_x+K_p)AV^2}=\frac{K_y}{K_x+K_p}$$

The L/D of the entire machine will, at any angle, always be less than the L/D of the wing alone, depending on how large is the K_p or parasite resistance coefficient referred to wing area.

Problems

1. A monoplane has a wing area of 300 square feet, Clark Y, and is loaded 9 pounds to the square foot. What is the minimum speed?

2. (a) What will be the incidence for minimum wing drag? (b) What will be the speed at minimum wing drag? (c) What will be the minimum wing drag?

3. The maximum speed desired is 120 m.p.h.

(a) What will be the wing horse-power at this speed?

(b) If the engine is 200 horse-power, and the propeller efficiency is 78 per cent, what will be the horse-power available at top speed?

(c) How much horse-power will be left over to overcome parasite drag?

(d) What will be the wing drag at top speed?

(e) What will be the parasite resistance coefficient?

(f) What will be the parasite resistance coefficient referred to wing area?

(g) What will be the equivalent flat plate area of the airplane?

4. Assuming that the parasite resistance coefficient to be a constant, what will be the overall L/D of the airplane at: (a) 0 degrees incidence? (b) 8 degrees incidence? Plot a curve of L/D against angle for the entire airplane.

Does the best L/D of the whole airplain occur at a smaller or larger angle than for the wing alone? Explain your result.

5. Plot curve of (a) wing drag; (b) wing horse-power; (c) parasite drag; (d) parasite horse-power; (e) total drag, (f) total horse-power.

PROBLEM 5

Velocity M.P.H.	Wing Drag K_xAU^2	Wing H.P. $=\frac{DU}{375}$	Parasite Drag $=.0032\times 6.74\ V^2$	Parasite H.P. $=\frac{D_pV}{375}$	Total Drag $D_t=D_w\ D_p$	Total H.P. $=HP_w\ HP_p$
60	183	29.2	77.6	12.4	260.6	41.6
70	146	27.3	105.7	19.7	251.7	47.0
80	130	27.7	138.0	29.4	268.0	57.1
90	132	31.7	174.8	42.0	306.8	73.7
100	148	39.5	216.0	57.6	364.0	97.1
110	163	47.8	261.0	76.7	424.0	124.5
120	177	68.0	311.0	99.2	488.0	157.2

6. Draw an approximate curve of horse-power available, assuming that at 70 m.p.h. the available horse-power is only half that at maximum speed. What is the maximum excess power. What is the maximum rate of climb in feet per minute?

Answers to Previous Problems

1. A = 300
w/A = 9
$K_y$max for Clark Y = .00333

$$V\text{ min.}=\sqrt{\frac{W}{K_y\text{max}\ A}}=\sqrt{\frac{1}{K_y\text{max}}\ \frac{W}{A}}$$

$$=\sqrt{\frac{1}{.00333}\times 9}=\sqrt{2700}$$

$=52$ m.p.h.

2. (a) From Fig. 1 minimum wing drag occurs at $-3°$.

(b) Min. Kx = .00004 at $-3°$
Ky = .00045

$$V=\sqrt{\frac{W}{A}\ \frac{1}{K_y}}=\sqrt{\frac{9\times .1}{.00045}}$$

$V=141$ m.p.h.

(c) $D=Kx\ AV^2$
$=.00004\times 300\times 141^2=239\#$

3. Vmax = 120 m.p.h.

(a) $L=Ky\ AV^2$

$$\frac{L}{AV^2}=\frac{W}{AV^2}=K_y$$

$$\frac{9}{(120)^2}=\frac{9}{14400}=.000625=K_y$$

.000625 at $-2.3°$ $K_x=.000041$

$D=K_x\ AV^2$
$=.000041\times 300\times(120)^2=177\#$

$$\text{Wing HP}=\frac{DV}{375}=\frac{177\times 120}{375}=56.8 \text{ h.p.}$$

(b) $200\times .78=156$ h.p. available

(c) H.P. left over to overcome parasite drag $156-56.8=99.2$ h.p.

(d) Wing drag = 177#

(e) $\text{h.p.}=\frac{DV}{375}$

$$99.2=\frac{D\ 120}{375}$$

$D=310\#$ parasite drag

(f) A = 300
D = 310#
V = 120

$$K_x=\frac{D}{AV^2}=\frac{310}{300\times(120)^2}$$

$=.0000717$

(g) Equivalent flat plate area
$D=.0032\ AV^2$
D = 310
A = ?

$$V=120\quad\frac{D}{.0032V^2}=A$$

$$\frac{310}{.0032\times 120^2}=A=6.74 \text{ sq. ft.}$$

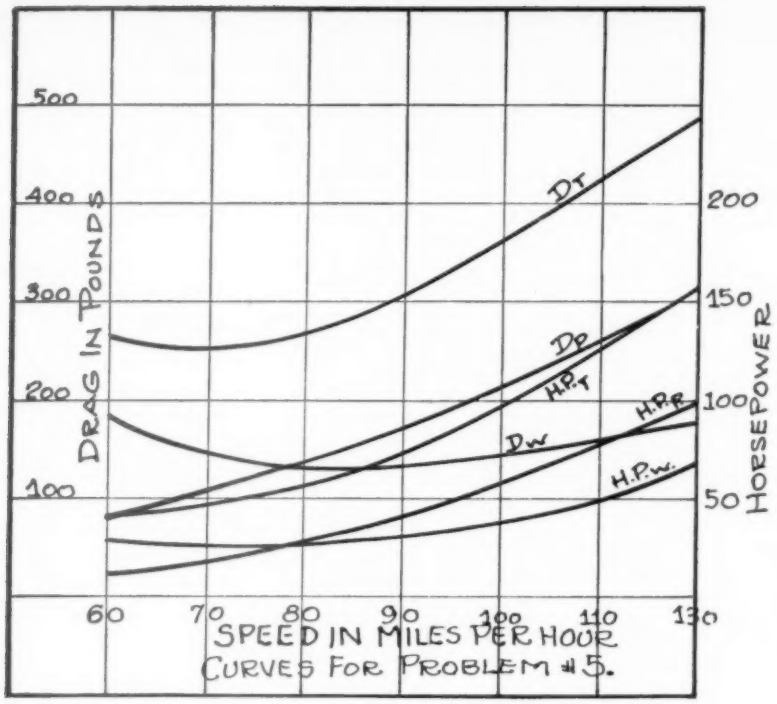
4. At 0° incidence $K_y=.00105$

(a) $K_x=.000051$

$L=K_y\ AV^2$

$$\frac{L}{K_yA}=V^2=\frac{9}{.00105}=8560$$

$V=92.4$



$D_{wing} = K_x A V^2$
$= .000051 \times 300 \times 92.4^2$
$131\#$
$D_{parasite} = .0032 \times 6.74 \times 92.4^2$
$185\#$
$D_{total} = 131 + 185 = 316\#$

$$\text{Overall } L/D = \frac{2700}{316} = 8.55$$

(b) 8° incidence $K_y = .00250$
$K_x = 00017$

$$V^2 = \frac{L}{K_y A} = \frac{9}{.00250} = 3600$$

$V = 60$ m.p.h.
$D_{wing} = 00017 \times 300 \times 3600$
$= 183\#$
$D_{parasite} = 0032 \times 6.74 \times 3600$
$= 77.6$ lbs.
D_{total} 260.6# total

$$L/D = \frac{2700}{259.6} = \frac{10.4}{}$$

The best L/D of the whole airplane occurs at a larger angle than that for the wing alone. For any particular angle of attack the L/D is reduced upon the addition of parasite drag, but the effect is more noticeable at smaller angles where the parasite drag is a large part of the total drag. Thus the maximum L/D shifts to a larger angle of incidence.

The National City Company and Boeing Stock

By Armstrong Perry

CONSERVATIVE financiers who considered aviation as too young an industry to be interesting from a financial point of view were surprised when they read in the newspapers recently that The National City Company had invested heavily in stock of Boeing Airplane & Transport Corporation.

The National City Company, whose headquarters are in New York City, is one of the large financial corporations in the Wall Street district. Its policies are conservative. It was natural that those who looked upon aviation as still in the experimental stage should wonder why this company became interested in a concern whose business is based on the manufacture, sale and operation of aircraft.

There is no mystery, however, in the action of The National City Company. To begin at the foundation of its faith in aviation, there are two major divisions of the industry, manufacturing and transport. And aircraft manufacturing has likewise two main divisions, the manufacture of military equipment and the manufacture of commercial equipment. There are five companies in the United States that manufacture military aircraft and about seventy that manufacture commercial aircraft.

The United States government is the largest purchaser and user of aircraft in this country. During 1927 the Army purchased 269 airplanes. Together with spare parts, the total cost was about $6,200,000. Only about $200,000 of this amount was spent for lighter than air equipment. The Army purchased also 275 aircraft engines and spare parts at an additional cost of about $2,500,000.

In the same year the Navy purchased 316 airplanes and spare parts, at a total cost of about $7,700,000, and 695 engines and spare parts at an additional cost of about $8,100,000.

These figures, showing that the United States government spent $24,300,000 in 1927 for airplanes, do not include expenditures for accessories ordered separately from contracts for major equipment.

The United States Post Office Department was a pioneer in the field of air transport. On May 15, 1928, it dispatched the first mail carried by airplane in this country. By December of that year 218 miles of air mail routes were in operation, with two station stops. Less than ten years later, in July, 1928, there were 10,816 miles of air mail routes with 72 station stops.

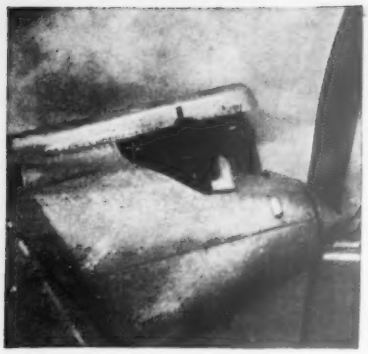
In that decade mail planes flew 22,577,147 miles and carried 9,910,896 pounds of mail.

At present about 14,000 pounds of air mail are carried daily in this country. Planes operated by air transport companies fly more than 40,000 miles a day.

Mr. W. Irving Glover, Second Assistant Postmaster General, who is in charge of the air mail service, predicted recently that within two years every city of 50,000 or more inhabitants in the United States would be located on one or more of the air mail routes, and that the air mail would carry an increasing quantity of packages weighing from one to three pounds each. Already 108 cities are served by commercial airplanes on regular schedules. The combined population of these cities and the areas immediately surrounding them is 60,000,000.

Air mail is now carried over 12,397

(*Continued on page* 88)



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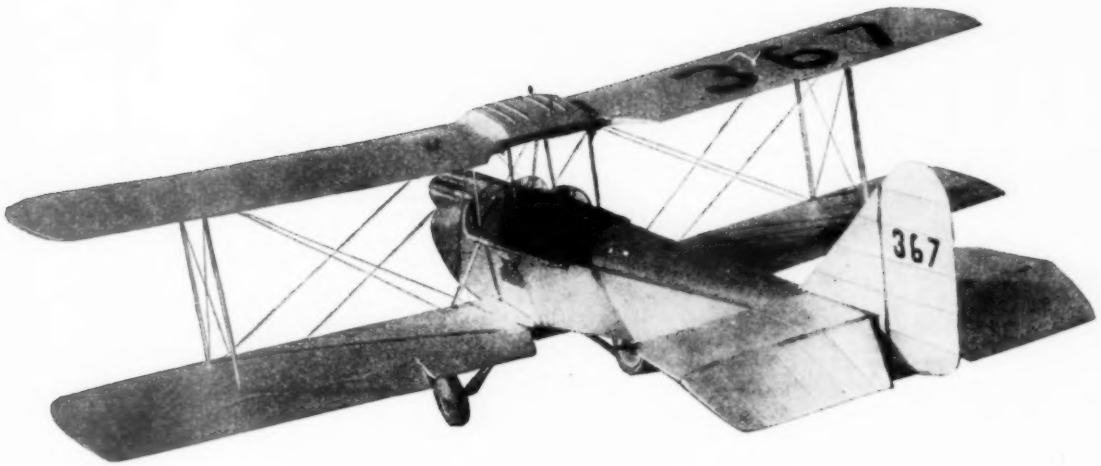

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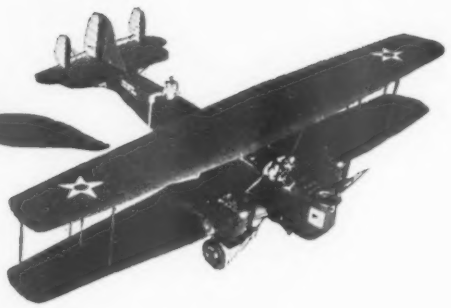

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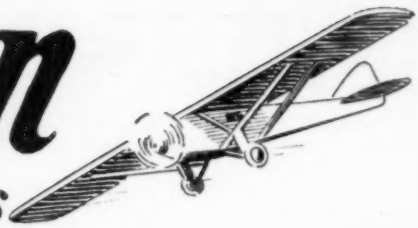

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A WORD ABOUT JACK STINSON

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The COST of this unusual course of instruction is but $60.00, and yet it makes your start on the road to a responsible position. The exceptionally convenient terms are only $10.00 with your enrollment on the attached coupon and weekly payments as low as $2.00 per week. With such terms and at such a low cost you cannot now afford NOT to know Aviation. Mail the coupon today! Don't let another day slip by! It may mean the indefinite postponement of your success.

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CURRENT COMMENT

Harley W. Mitchell

IT may be that we enjoy the editorials of Mr. C. C. Grey of The Aeroplane, our English contemporary, because he agrees with us and has a piquant style, but we like to think that it is because his reasoning is so sound. In a recent issue he quotes Winston Churchill to the effect that "Civil Aviation must fly by itself," and proceeds to agree with him heartily, to the effect that "if Civil Aviation had had to fly by itself ever since then (the Armistice) instead of being tied to the apron strings of Service Aviation, it would have made much greater progress.

Opposition to Subsidies

Subsidies have often been attacked as un-American, but the true argument against them is that they are poor business. A distinct difference can be drawn between subsidies and co-operation. The furnishing of equipment, the rebate of fares or a percentage of traffic income, the guarantee against loss —all these may be classed as subsidies. In our opinion, though, the development of new designs through Army and Navy channels, the lighting of postal airways and the establishment of routes that correspond to navigable waterways are matters of co-operation that not only may be properly sought from governmental agencies, but rightly demanded of them.

Do Subsidies Really Pay?

Mr. Grey maintains that if it were not for the British subsidies, which extend, as a matter of Defense Policy, to all forms of transportation, that American millionaires would not be able to travel in the comfort and at the speed of today. "A somewhat similar result, so far as the American passengers are concerned," writes Mr. Grey, "is achieved by subsidizing the Imperial Airways. But the real profit that we get out of what seems to be a silly arrangement is that we know more about running steamship lines and running air-lines than any other country in the world. In spite of the lamentations of the Air League and other critics of the Air Ministry we have the testimony of the head of the German Luft Hansa that Imperial Airways is a model of how an airline ought to be operated."

Both Sides of the Question

Mr. Grey thus finds himself on both sides of the question of subsidies, a position that we have often been in. That there are advantages and arguments for the subsidy we have no doubt, and the excellence of Imperial Airways may be one. Still, the thought insists upon cropping up that Imperial Airways might still be the model of all the air lines without the subsidy. Why, of all qualities, the inhabitants of the tight little island should have been blessed with extra ability along transportation lines is a mystery, but the fact remains that Britons have outstanding administrative ability in this particular business.

COMMERCIAL aviation, particularly transport aviation, has received great impetus in this country in the past few months. It is undoubtedly in advance of public requirements at the present time. This is spoken in no critical fashion, and is not meant as a warning. It is the habit of American capital to furnish facilities or a product before the market is fully developed. Advertising and the mere presence of facilities for purchase rapidly develop the market.

Faster Growth Is Possible

Critics claim this to be a wasteful and expensive way to develop business; but criticisms have a way of coming home to roost. No facts at hand, and none that we have heard, could ever have justified the decrease of air mail postage from ten to five cents, from a financial standpoint. The reduction was made in the face of criticism of this particular type, and the results are already known. Air mail has increased to a point thought impossible under the ten cent rate, and there will soon be financial justification for this move.

IT is a typically American move to provide extensive air facilities in the absence of assurance of passenger traffic sufficient to support these lines. A comparatively short time will elapse before these facilities will be crowded with a traffic that is not yet in existence. Prices for travel will be reduced below actual costs and increased traffic will make the reduction pay dividends.

Investors vs. Government

It is simply a case of the investor carrying the subsidy, rather than the Government. In the British method, the nation as a whole may be said to bear a burden which we in this country lay on private investors. Instead of depending upon government revenue, ultimately derived from taxation, to see our airlines through their first period of adjustment we depend upon the far-sightedness of individuals and business groups able and willing to undertake this responsibility privately. The thinking investor, acquainted with past events in the automotive and the radio fields, realizes that he permits an impounding of his dividends for a short period in the interests of good business, with the result that later dividends not only make up for the incubation period of the enterprise, but return him many fold for his wisdom.

Where Men Are Made

"ALL THAT I AM OR HOPE TO BE"

Abraham Lincoln owed much to his Mother. Perhaps it was her great loving sympathy that inspired him to arduous years of study and application—the stern struggle for learning that fitted him ultimately for the Presidency.

PARKS Air College graduates are more fortunate, science has miraculously shortened the fight for success. They have been trained in the most modern aviation school and can say with similar pride. "'All that I am or hope to be' I owe to the decision I made and the help I received." Their pride finds its tangible expression in greater salary and success in the great new industry of aviation.

THIS IS YOUR OPPORTUNITY!

Aviation stands pleading with you to grasp opportunity by the forelock. Aircraft mechanics, riggers, inspectors, designers, draftsmen, instrument makers, metal workers, woodworkers, and many other highly paid men are needed urgently in the rapidly increasing number of airplane factories springing up over the country.

POSITIONS PLENTIFUL

4000 commercial airplanes were produced last year in approximately 140 airplane plants always ready to hire trained workers. This year the increase will be tremendous—and next year—and years to come. It is estimated that the value of commercial airplanes sold in the United States this year will exceed $75,000,000.00. This enormous fleet of airplanes must be built by trained men.

THINK WHAT THE FUTURE HOLDS

A position in an airplane factory is only the start for a man of ambition. Think what the future holds in the nature of high priced executive positions in transport companies, mail lines, photographic work, mapping, prospecting, as airport managers, and in private flying. "He who hesitates is lost." "Time and tide wait for no man." This is your opportunity knocking.

DECIDE NOW

There are already eight transport companies with sixteen thousand miles routed and five thousand more miles in various stages of preparation, with at least thirty new companies under promotion, as well as the thousands of airports springing up all over the country. You are needed now. "All that you may be" depends upon your initiative—your immediate decision.

PARKS AIR COLLEGE LEADS

Parks is the largest and most completely equipped air college in the United States. When you graduate from Parks, every airline operator, airplane factory executive, and airport manager will know that you are thoroughly trained. They know the thoroughness of Parks training and have confidence in Parks graduates.

THE VERY BEST EQUIPMENT

Parks equipment includes everything in modern power plants: Whirlwind, Liberty, Caminez, Velie, Hispano-Suiza, OX5, and other famous engines are demonstrated and explained in regular class room instruction.

YOU DO ACTUAL WORK ON AIR MOTORS

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Timing Equipment at the South Pole

By J. P. V. Heinmuller

WHEN Tom Mulroy, chief engineer of the Byrd Antarctic Expedition started the "City of N. Y." on observatory time, for New Zealand as the first stop, the ship was carrying food and material for three years, notwithstanding the increase in the personnel from fifty-five to seventy-nine men. Nothing was left to chance, but every little item on the supply ship was given full test and consideration before acceptance in order to make the journey successful.

The scientific timing equipment of the expedition was planned for many months ahead, and can be considered the most complete equipment ever used on a polar expedition. Among the numerous time pieces taken along by this expedition, there are a number of small size thirty-six hour box chronometers which are transported in felt lined mahogany cases. Navigator Ralph F. Shropshire of the expedition will make scientific observations with these time pieces. For the first time there will be available small chronometers to make observations during trips on dog sleds in the Antarctic regions.

It is interesting to note that modern horologic science has again made new progress, and, today, small size chronometers replace the old fashioned marine chronometers. Formerly a large marine chronometer was required for chronometric calculations for longitude and latitude. The pull of the main spring on the old time marine chronometer, rendered uniform by use of a fusee which equalizes the main spring power, necessitated formerly a large instrument, but today, with new inventions in horology, a fine watch movement is used for these chronometers, and the anchor escapement has performed just as well at the U. S. Naval Observatory in Washington, and at the Kew Teddington and Geneva Observatories, as the old fashioned marine chronometer detent escapement.

Celestial avigation will be done in four airplanes, a Ford, Fokker, Fairchild and G. A. C. Aristocrat. They are all equipped with large size one-fifth second chronographs (Fig. 2). A special chronograph hand with register will allow scientific calculations as to the lifting capacity, speed, velocity of the wind, etc. They also have a large size radium dial aviation watch for night observations with large second hands. The large second hands in the center (Fig. 3) are used for calculation of the speed and proper get-off on runways, etc. A new instrument about six inches in diameter giving the duration of every individual flight, as well as the computation of flights up to 192 hours is also included in the equipment. This instrument also was a stop and start arrangement, and is especially useful for calculation of the gasoline consumption during

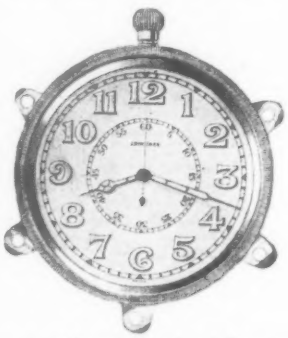

Fig. 2. Chronograph with second hand in the center.

Fig. 1. Large size, one-fifth second chronograph.

Fig. 3. This instrument gives the duration of every flight, as well as a computation of flights up to 192 hours.

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Price $2,500 (less motor)—motor optional.

SPECIFICATIONS

Dimensions

Length overall	21 ft.
Height overall	8 ft.
Span	32 ft.
Chord	60 in.

Areas

Wings	312½ sq. ft.
Horizontal tail planes	33.2 sq. ft.
Vertical tail planes	8 sq. ft.

Weights

Weight empty (Curtiss Challenger) 170 H.P.	1,390 lbs.
Useful load	1,357 lbs.
Pay load	795 lbs.
Gross weight	2,749 lbs.

Construction

Fuselage—Welded steel tubing, cover fabric.

Wings—Spruce spars and ribs. Fabric covered.

Ailerons—Steel tubing—fabric covered.

Tail Planes—steel tubing—fabric covered.

Landing Gear—Split axle, tread 7' 4".

Equipment

Tachometer, altimeter, oil pressure gauge, oil temperature gauge, switch, choke, gas shutoff, gasoline gauge for each tank, compass, air speed indicator, fire extinguisher, safety belts, navigation lights, dual control. Elgin Watch Co. instruments, Sherwin-Williams finishes, Celotex fabrics, Goodrich tires, Kelsey wheels.

PERFORMANCE

(170 H.P. Curtiss Challenger)

High Speed	125 M.P.H.
Cruising speed	105 M.P.H.
Landing speed	30 M.P.H.
Ceiling	18000'
Climb	1000' P.M.
Fuel capacity	60 gals.
Cruising radius	650 M.

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FLY IN SAFETY

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flight (Fig. 4). Specially built split-second timers will be used for drift indicators during flying, in order to enable the navigator or pilot to calculate the

Fig. 4. A split-second timer, specially built to serve as a drift-indicator.

ground speed of the plane between two given points (Figs. 5 and 6).

The navigator uses also a set of two specially built large size eight-day instruments, one giving Sidereal time which corresponds to a gain of three minutes and fifty-six seconds in twenty-four hours, and the other instrument giving Greenwich Mean Time (Fig. 7). The days are divided into twenty-four hours, and this instrument will allow very precise calculation by the Willson

Fig. 5. This split-second timer will also be used for calculating drift.

Octant, an instrument which has been greatly improved lately.

Lieut. Comm. Weems, who has been teaching Col. Lindbergh celestial aviga-

Fig. 6. A twenty-four hour chronometer gives Greenwich Mean Time.

tion, in recent tests in a Navy Mail plane making daily trips between San Diego and San Pedro, had an average error of 6.6 miles on nine timings. With a new sextant, however, Navigator Shropshire, of the Byrd Expedition, had errors of less than one mile on the try-out, using aero chronometers.

Another new instrument is a sextant camera, invented by Lt. Comm. Pierce. The dial of this specially constructed chronograph does not show any numerals, and is made of black enamel in order to get the minimum reflection through the mirror effect of the camera sextant. This instrument actually pho-

Fig. 7. The Pierce sextant camera takes a photograph of the watch dial and of the sun simultaneously.

tographs the watch dial, and will allow precise observation of location. It will actually prove without doubt when and where Commander Byrd will fly over the South Pole. Fig. 8 shows a picture of the watch, with the second hand giving the position of one observation. The sun is shown in the photograph on the watch dial. The navigator actually calculates and confirms his position with this photo. This will open new possibilities in aerial navigation. Science is following with great interest the tests made with this sextant camera.

Capt. A. C. McKinley, the aerial photographer of the expedition, will have split-second timers to enable him to take correct exposures up to the fraction of a second. Chronograph strap watches (Fig. 9) will be used extensively for rechecking of observations made from the new bubble sextant, perfected by the late Comm. Noel Davis.

Dr. Francis Dana Coman, of Johns Hopkins University, the head physician of the Byrd Expedition, will use split-second timers for all medical observations, such as measurement of pulse and for administration of anesthetics, and various medical researches to be undertaken during the expedition (Fig. 10).

The leading members of the Expedition will wear specially constructed strap watches. While it is easier to obtain perfect accuracy in a pocket watch owing to its large size, a strap watch in

Fig. 8. The chronograph strap watch is to be used for rechecking observations made with the bubble sextant.

order to perform within a few seconds a month, must be specially regulated and adjusted to heat and cold. In addition to this special regulation, the watches carried on the arm by the members of the expedition have double silver cases, which make the entire bracelet dust and moisture proof. By applying a coat of vaseline around the bezel and glass these watches will be entirely waterproof. The dials are made with radium figures for visibility during the night, and the glasses are unbreakable. Since the watch is in a cup case, the bezel must be unscrewed in order to rewind it. Men in the Arctic do not like pocket watches for the simple reason that outdoors it is not always convenient to open fur pieces in order to look at the watches. The extreme variation of temperature does not improve the running of the pocket watch, and experience has shown that it is advisable to subject watches to an even temperature of heat or cold.

Watchmakers, as well as manufacturers of fine instruments in general, are especially anxious to have a study made in the Antarctic regions in regards to a

Fig. 9. This type of split-second timer is furnished the medical members of the expedition.

non-freezable oil. It is known that a certain penguin bird, found near the South Pole, can live in the coldest climate, because it has glands filled with a non-freezable oil. It is hoped that through observation some information will be obtained on this subject, and also some interesting data as to the accuracy of time pieces, which will prove beneficial in the manufacturing of the better kind of observatory time pieces and instruments.

After all it takes a flight to convince you

IN previous advertisements we've been telling you a lot about the mechanical features of the COMMAND-AIRE plane.

But now we want you to try one—either as pilot or passenger—and are going to make it easy and convenient for you to do so. For after all, it takes a flight to convince anyone as to the performance—including stability—of a plane.

Thus we give you below the names of COMMAND-AIRE distributors in various sections of the country. We know that any one of them will be glad to demonstrate the COMMAND-AIRE performance to you.

Whether you are interested in handling COMMAND-AIRE planes, or merely interested in flying one, we are happy to make it easier for you to test the positive stability of the COMMAND-AIRE where it should be tested—in the air.

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Plum Puddings and Blizzards

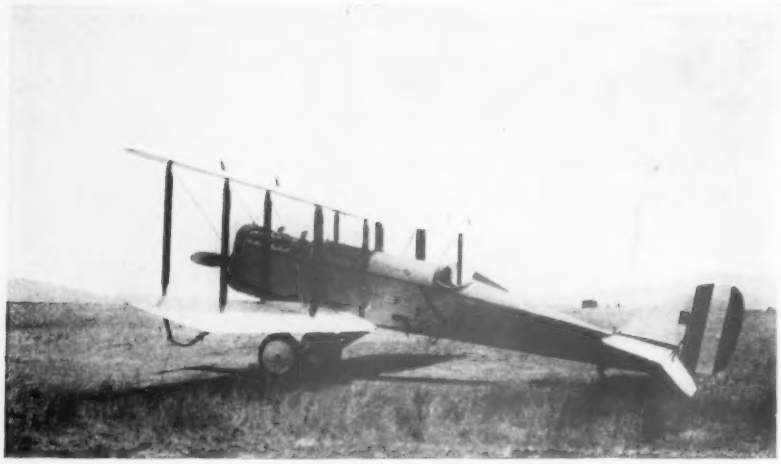
By C. K. Vance

FIRST of all, let me give a bit of advice. Never eat Thanksgiving plum pudding if you expect to fly the next day. I did that very thing and lived to regret it.

It was Thanksgiving Day, 1923, and I was sharing a very wonderful home dinner with a lady. (This lady is now Mrs. Vance.) The turkey had been disposed of and among the various kinds of dessert was this plum pudding which mother-in-law had so carefully prepared. Father-in-law, a jovial little Scotchman, advised against eating it with the remark, "I'm warning you, C. K., if you eat that you'll never get over the Hump tomorrow," and I didn't. All of which brings on the story.

Left Wing Low is looking for more Forced Landing Stories like this one in exchange for a $100 Longines Watch.

The day I left San Francisco the weather reports read about as follows: "Summit snowing, ceiling and visibility totally obscured," "Reno broken clouds, solid thick cloud bank down on mountains west, visibility west six miles, east unlimited." The San Francisco Bay region and the Sacramento Valley were practically clear with only a few scattered clouds. In instances such as this we usually climbed over the storm, flying a compass course, coming down through the broken clouds at the terminal, in this case Reno.



One of the De Havillands used by the Government in carrying air mail five years ago.

The Air Mail at that time was government operated and flew every day except Sundays from Crissy Field, the regular army field, in San Francisco. Night flying had not as yet been incorporated in the regular Transcontinental schedule, and no extra postage was required. We were due east for Reno at two-thirty in the afternoon, at which station the mail was trained to be picked up further along the line for another airplane ride.

We were then using Liberty motored DeHavillands and regardless of all one hears about flying coffins, old crates and what-not, these planes certainly served a very useful purpose and maintained a service that the modern mail planes have bettered but very little. In my seven years of mail carrying over the Sierra Nevada Mountains, there has been but one mechanical forced landing and that with a modern motor, a very remarkable testimonial to the ground force back of all the flying.

Everything went fine until I reached the summit where the clouds reached highest into the clear blue above. Skirting these beautiful clouds, formed into odd shapes and sizes, it was difficult to realize that a tremendous storm was raging below, the first one of the season. At an altitude of fifteen thousand feet, I reached the ceiling of the plane and try as I would, I could not gain another foot. The clouds seem to rise in a perpendicular barrier challenging me to come on and try to get over. I paraded up and down parallel to the mountain range, hoping to find a low spot to get through, but after a half hour I gave up and started the return trip to the coast. With my eyes to the east I had neglected to keep tab on the weather west and in the attempt to return I found the clouds closed in behind me, and myself in the position of a pea rolling around in a saucer unable to climb out. Now I was in a predicament. I am not as a rule superstitious, but that plum pudding incident kept running through my mind. Perhaps the father-in-law was right.

Under the circumstances there was nothing to do but circle and wait for something to happen. Shortly the wind, which was blowing rather hard, opened up a small hole directly under me. Regardless of what was going on under those clouds, I thought it best to get down through the hole and at least land while I had motor power and perhaps get out altogether if the storm had risen a bit. I made a very tight circle with the motor throttled and came out from under the clouds directly on the regular course. It was good to know exactly where I was, but the knowledge did me very little good unless I could make my way out.

It was snowing hard, with only about a half mile visibility and just enough ceiling to circle. I headed to the north through various small canyons in an attempt to reach the railroad tracks but at every turn found clouds blocking my way.

Directly south was a plateau about a mile long and apparently covered with sagebrush. I had always had this place in mind as an emergency landing field and now I had an opportunity to try it out. Through the center of this space is a trail leading to an old mining settlement called Last Chance, in this instance well named. This small deserted town is now inhabited by a miner named Dave Ray, who with his wife and two fellow workmen, still find a bit of romance working the old diggings for what gold they can find.

I circled the town to attract their attention and perhaps fix myself up for an early rescue. I flew directly out the trail to the east end of the plateau and, swinging west into the wind, cut the motor, glanced at my safety belt and hoped for the best. It was just beginning to turn dusk and with good luck, I could make my way to the trail and into the settlement for at least a good night's rest.

Just as the wheels were about to touch the ground I cut the switch, pulled the stick back to stall in as slowly as possible and waited. I didn't wait long. The

The New Travel Air *four place* Cabin Monoplane

"Look! She's flying the ship—yet it's her first time in the air....Dual Control makes this possible."

"Just take the wheel at the right, up in front, and fly as easily as you operate your automobile. Turn wheel to the right and the right wing inclines downward; turn wheel to the left and the left wing inclines downward. Push right pedal to turn right and left pedal to turn left. Push steering column forward to nose down—pull it back to nose up. The combination of these operations gives you the desired maneuver.

"All the while the pilot at the other wheel is flying with you—*because the two wheels are synchronized and must operate together.* Thus the pilot easily and quickly corrects any deviation you might make from the flight path. You are flying while you are learning—no theory, but actual practice in the air.

"*The new Travel Air Cabin Monoplane is inherently stable, and in itself will automatically maintain straight and normal flight. The slightest movement of the controls corrects for any atmospheric variation.*

"Soon you will find it unnecessary to employ a pilot for you will have learned to fly—almost without realizing it, because of the dual control—the greatest single advancement ever made in aircraft construction." .....

The New 4 place Travel Air Cabin Monoplane is built out of long years of flying experience and is a worthy companion ship to the famous Travel Air 6 place Cabin Monoplane—Type 6000.

Full particulars and The Story of Travel Air on request, which illustrates and describes 9 types of Travel Air Models.

TRAVEL AIR COMPANY

The Standard of Aircraft Comparison

WICHITA, KANSAS

Snow sheds of the Southern Pacific Railroad near the summit of the Sierras. At the left is a glimpse of Donner Lake.

plane struck the brush, careened crazily for a second, up on her nose and over on her back with a crash. I instantly undid my life belt, falling out on my head and left wrist. Outside of a slightly sprained wrist, I found myself in good condition for a hike cross-country.

To my surprise I found, instead of low sagebrush, a six foot growth of manzanita brush. This brush grows very thick and has large, stiff branches, making an almost impassable mass. I spent very little time inspecting the damage to the plane but started blindly in the direction of the trail where I would find walking much easier.

The start was very ambitious, but the brush was wet with snow and as it was necessary to part the stiff branches with my arms, to form a passage, I soon became scratched about the face, my fur-lined flying suit was soaked through and I began to doubt my judgment in landing there. I pressed on, however, finally coming to a small clearing where a large tree had blown over, evidently many years ago. Here I stopped to get my breath and rest a bit. It was still snowing and getting quite dark so I made the decision to park right there for the night.

Examination of the old tree showed a bark capable of being peeled off and a dry, rotted center which would do for kindling wood to start a fire. The stump of the tree was still standing about two feet and had become hollowed with age. Having made my decision, I set about the business of making a fire.

The center of the stump was soon cleaned out and after heaping up a few letters I had in my pockets, together with dry wood from the log, I got out my first match. Struck on the box it flared and went out in the high wind which was still blowing. I had but four matches with me and after number three went out in the same manner as the first, I set myself for the final effort with the remaining one. Having scorched the paper a bit from the previous attempts seemed to help and this try was successful, much to my relief. The feeble flame needed no fanning, in fact, I had to stand in front of it to keep the wind from blowing it out. In a short time, however, it was blazing merrily, so, placing myself between the fire and a large clump

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Donner Lake, looking north through the Sierras on the transcontinental route.

of brush with the wind to my back, I proceeded to dry out.

It was now quite dark, the wind switched to the north and it stopped snowing. Within an hour the storm had broken up, but it turned very cold and I found it a very difficult matter to keep warm. The flying suit finally dried and I found it necessary to turn around constantly to keep one side from getting too warm and the other too cold.

I had nothing to eat except a few peppermint life-savers I happened to have with me. They lacked a lot of being life savers and the longing for something to eat occupied a great deal of my time. The temperature must have been well below zero and although the source of fuel supply was only about twenty feet away I found myself well chilled before I could collect an armload of wood and return to the fire. There was no chance for sleep as the fire needed constant watching and replenishing with fuel.

Waiting until daybreak developed into a tedious proposition but with the first ray of light I put out the fire and started again on my trek to civilization and breakfast. It took about an hour and a half to reach the trail and an additional hour to reach the mining camp.

At the edge of the camp, I met one of the inhabitants going to work. He showed absolutely no surprise when he saw me, saying that they had heard and seen me fly over the night before and had wondered if I were in trouble. He directed me to Dave Ray's house where a fine breakfast of bacon and eggs was set before me. I ate, but without much enjoyment. What I wanted most, now that I had the breakfast, was a little sleep. I did get a little but I felt it my duty to get the mail out to the railroad and on its way.

By nine o'clock Dave had rounded up two mules and one horse to make the trip back to the plane for the mail. Dave rode the big black horse, I managed to mount one mule after some difficulty, and the other mule carried all the riggings to hold the three hundred pounds of mail. If my mule had been very fast on his feet, I imagine I would never have made the grade, but he seemed about as ambitious as I felt which failed to make me mad. Guessing at the approximate position of the wreck, we started to force our way through the thick brush, finally getting sight of the lower wing rising above the growth. After reaching the plane we cleared a small area to make the job of loading down the pack mule a bit easier. The mail was easily removed from the wreck and Dave, with knowledge gained through years of experience, soon had the load packed to a nicety. After giving the plane an inspection for the purpose of making my report, we turned back to camp for the start to Michigan Bluff, the first town and the terminal of a ride I'll never forget.

By the time we had reached camp it was nearly noon and, after eating a bite of lunch to tide us over until we reached the end of the trail, we started on our way. The distance airline is seven and a half miles; by trail it took us eight hours.

We had two deep canyons to cross, both of which descended to the river at an angle of about sixty degrees with a corresponding upgrade on the other side. The trail, of course, did not go straight down but wound back and forth with numerous hairpin turns. In places the trail had been cut in on the side of the canyon, so narrow that it would have been impossible for two pack trains to pass. I did not ask, but suppose they must have had particular times to leave either end in order to meet at a designated place. I know at times it gave me heart failure to look down at the river, much the same experience that one has looking off the top of a tall building.

Crossing the flat areas between the canyons was without incident but up and down the sides gave me a plenty to worry about. I was (rather the mule was) bringing up the rear of the procession and, therefore, had some opportunity of observing how it should be done. After a short time I decided the mule knew more about it than I did and accordingly dropped the reins. Some of the hairpin turns were so narrow and sharp that we had to back up to get around the corner and when an occasional step too close to the edge caused a bit of earth or rock to go sliding down the side, I began to wonder if we would ever make it. The suspension bridges across the turbulent rivers were annoyingly long and swung to and fro under the weight of the train. They were built of long cables anchored in the sides of the canyons and from which was swung a sort of wooden platform. They are dizzy structures to navi-

Down in six feet of manzanita brush at Last Chance, California, near the summit of the Sierras.

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gate but they have withstood the years and I had to use them whether I liked it or not.

The sun went down just as we crossed the second river and darkness fell rapidly and with no moon to light up the trail, it was impossible to see ahead or even so much as make out the mule's ears. My mule seemed to have a way of his own so far as speed was concerned. He would stop suddenly, take a short rest and then, with increased speed, catch up with the pack mule and horse ahead, after which he would repeat the operation. The catching up was all right, but the stopping worried me, especially in the dark. Evidently guessing my mind, Dave informed me that Mr. Mule had been over this trail more times than he could remember and knew exactly what he was doing, which was a lot more than I knew. Once we stopped suddenly and immediately I heard a lapping of water. The mule was drinking and I couldn't even see the trough. From then on I gained confidence and decided that that mule had a lot more sense than some humans I know.

About eight o'clock we reached the top of the last grade and, sighting a few lights ahead, I knew my mule ride was at an end. Our entrance into Michigan Bluff must have been a sight for the natives to remember. A helmeted figure clad in a fur-lined flying suit, was riding a mule to town. It must have been as awe-inspiring to them as it was embarrassing to me.

I at once got in touch with San Francisco and gave them the first news of my whereabouts. I secured a car and, after loading the mail in the rear seat and myself along side it, we headed for Colfax. I was too tired to care what kind of road we were driving over or how good the driver was. The next I knew I was awakened in front of the postoffice in Colfax.

Turning over the mail to the postmistress for training to Reno, I secured a room at the hotel where again I was soon fast asleep. I slept like a log and after a seemingly short time, the clerk informed me that the train for San Francisco was about due. Getting out of bed seemed a little difficult and it at once became evident that I would have to eat a few meals off the mantel.

Arriving in Oakland, I at once went aboard the ferry boat and purchasing a Sunday morning paper, I sat down feelingly at the lunch counter for breakfast. In glaring headlines it announced to the world that pilot Vance was safe.

Over my shoulder a gentleman (he must have been a gentleman) remarked, "I see they found that lost mail pilot. I'm sure glad."

To which I replied, "Me too."

Narrow suspension bridge across the American river canyon over which pilot Vance rode the mule while returning to civilization.

Where pilot C. K. Vance made a forced landing with the mail, Nov. 30, 1923.

Book Reviews

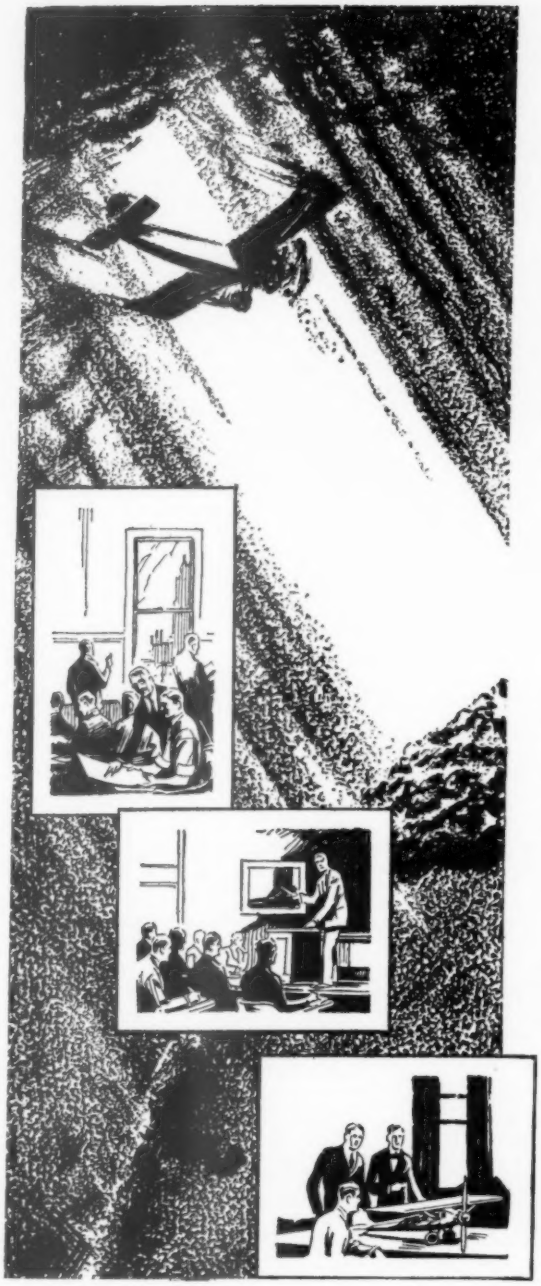
THE FLIGHT OF THE SOUTHERN CROSS, by C. E. Kingsford-Smith and C. T. P. Ulm. Pub. by Robt. M. McBride Co., New York: 1929. 295 pp. Illus. $2.50.

Among the really impressive flights of all time no effort yet recorded will have a more enduring place than the achievement of the Southern Cross in flying the Pacific. Had the Pacific flight been undertaken earlier in the course of transoceanic attempts it is doubtful whether it would have been as completely successful as it proved to be. Certainly, had it been successful, other oceanic crossings would have been more or less in the nature of anti-climaxes. One has the feeling of approaching a kind of summary of all the aeronautical accomplishment of the past five or six years in considering the flight of the Southern Cross.

The record of this adventure has tremendous narrative interest, because it is a story not only of the flight itself but also of the years of hoping and months of planning which preceded the actual take-off from Oakland. Squadron-Leader Kingsford-Smith and Flight-Lieutenant Ulm at first independently, and later jointly, nursed along for some ten years the desire to cross the Pacific by air. The struggle to awaken anything more than curiosity in the minds of people in general, and among potential financial backers of the project in particular, was a sharp one. At last, after Ulm and Kingsford-Smith had entered into a legal partnership in order to further their plan, some money did actually appear. The flyers went to America, and preparations for the flight were begun. A tri-motor Fokker was purchased from Sir George H. Wilkins.

But the money, never plentiful, very

(*Continued on page* 92)



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A Weather System for Night Flying

By F. C. Hingsburg

Chief Engineer, Airways Division, United States Department of Commerce

WEATHER is one of the uncontrollable factors that seriously affect the reliability and safety of air transportation and, therefore, influence the air navigation facilities that must be provided on airways. Candlepower and spacing of lights, as well as location of intermediate landing fields, are determined in conjunction with the study of weather conditions encountered on an airway route. An adequate weather service and communications system, in addition to aids to navigation along the airway, is essential for the full development of a dependable and safe air transportation system. The establishment of safety aids essential for this purpose has been authorized by the Air Commerce Act of 1926. Airway facilities may be classified into two groups: first the facilities designed to make flying feasible and safe under conditions of poor visibility and thick weather and, second, the safety aids that are required to bring airplanes safely to a well-lighted and equipped landing field when hazardous weather conditions are encountered.

Under the Air Commerce Act of 1926, the Weather Bureau is the agency responsible for collecting and disseminating weather information. The Airways Division operates in connection with the Weather Bureau in disseminating weather information along airways. The Weather Bureau maintains personnel at the principal airports to analyze and interpret weather reports. The Airway Division now maintains twenty-eight radio stations for the exchange of weather information and dispatch of airplanes, this service being supplemented by telephone and teletype communications. The present system of weather information is the expansion of the system initiated by the Post Office Department, which has served for more than 10,000,000 miles of flight, and has established a fine record of performance. Nevertheless, the system cannot be considered altogether satisfactory. The pilot receives the weather information and forecasts before taking-off and concerns himself with weather conditions he may encounter three or four hours hence at points 300 or 400 miles distant, whereas, the bulk of his information turns "stale" and unreliable thirty minutes after taking-off, due to rapidly changing weather conditions. The operation of large passenger airplanes makes it imperative that a more comprehensive weather and communications system be established. An adequate weather communications system should convey to the pilot enroute the

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changes in weather and landing conditions, giving him reliable information as of the moment. It is, therefore, apparent that radio communications to aircraft is the solution of the weather problem.

Great progress has been made during the past year in the development of radio communications to aircraft. On the Transcontinental Airway, two stations have been in operation experimentally under the Airways Division for several months, and twelve additional radiotelephone transmitters are being installed at Cleveland, Bryan, Chicago, Omaha, North Platte, Cheyenne, Rock Springs, Salt Lake City, Elko, Reno and Oakland. These radio stations will soon be completed and a new system of control of airways operation will be initiated. The radio-telephone transmitters are of 2,000-watt capacity, broadcasting voice on 900 meters, with a reliable range of 125 miles. Apparatus for fifteen additional stations is on order for delivery seven months hence, and the additional stations will be established along other routes on which night flying takes place. In addition to the foregoing, a radiobeacon and communication station is now being established at Key West for the Pan-American Air Mail Service.

A new system of weather and communications service has been devised by the Weather Bureau and Department of Commerce to develop the greatest utility from the new radiotelephone facilities now available, and it is proposed to introduce this system on the Transcontinental Airway, using the stations now under construction. This system promises the degree of safety required by air transportation on a basis that permits unlimited traffic. Timely and accurate weather and landing conditions will be made available to any airplane, airport, landing field or individual, that cares to tune in. The information will be broadcast on fixed schedules. Any airplane equipped with a radio receiver will receive weather information at any point within the sector.

The Eastern Division of the Transcontinental Airway (between New York and Chicago) will be the first to be operated under the new system and will have the control center located at Cleveland, from which point the Weather Bureau, Air Transport Company and Airways Division will manage the operation of the service. The American Telephone and Telegraph Company has arranged to install an automatic telegraph typewriter system, under an agreement with the Airways Division, for instantaneous communication between the radio stations, landing fields along the route, the Weather Bureau and Operations Manager's office. By this system, a message written on a typewriter at any point in the circuit between Newark, N. J., and Cleveland will be transmitted instantaneously and written on a tape at all other points in the circuit. The radio operator at the Department of Commerce radio stations will broadcast the messages by radiotelephone.

The weather service, forming the basis of this new system, is founded on the regular weather reports gathered by the Weather Bureau, throughout the United States each morning and evening, supplemented by a secondary net of weather reports gathered at intervals of three hours from critical points in the vicinity of the airway route and further supplemented by hourly reports of weather and landing field conditions from intermediate landing fields, located sixty miles apart along the airway. The Weather Bureau representative analyzes the weather data and prepares a short-range forecast of weather conditions, predicting the track, movement and severity of storms, and all other vital information required for the safety of flying. The landing conditions at terminal and intermediate fields together with the short-range forecasts are to be broadcast from all radio stations in the sector once each hour on predetermined schedules. These reports will be followed by orders to pilots of airplanes in

(*Continued on page* 92)

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Sailplane Construction

By Alfried Gymnich

This is Installment Five of the series of articles by Mr. Gymnich on the construction of Sailplanes

FIRST of all it must be mentioned that for the sake of simplicity in construction a few changes have been made in the making up of the shop drawings as compared to the general arrangement drawing, whereby, however, the fundamental principle of the machine and the principal dimensions are not affected. We begin with the construction of the supporting surface or wings. First of all we supply ourselves with the material given in the list of materials and cut it according to the dimensions as given in the drawings. Only after the entire material has been prepared, do we start on the actual construction, and then we start with the ribs.

We differentiate among three kinds of ribs, namely the full length main ribs (2), the auxiliary ribs (2b) and the ribs the ends of which are designed as transversal rudders (2a). Even though they differ from each other in their application, their shape is always the same down to the rear beam, in consequence of which our construction work is made considerably easier. The girths of the ribs consist of T-shaped spruce lists upon which the straps are glued in a triangular joint and secured with a light wire pin. The points of junction thus made are then plated over or covered with the thinnest plywood and this is also done by gluing and light nailing. The ribs are made by aid of a pattern which we prepare in the following manner: The shape of the ribs including the girth and the strap are carefully drawn upon a smooth and flat board. The transfer of the drawing is done best by means of a pantograph in order to assure an accurate reproduction of the shape in full size. Around the drawing we nail all along upon the board small pieces of lists in such a manner that the rib girths and the straps, when they are laid between these nailed-on lists, tally accurately with the drawing and lay undisplaceably tight. Likewise the openings in the ribs, through which the beams are pushed later on, are lined out upon the pattern with a small list which corresponds exactly to the cross section of the beam. With this building method we arrive at this result that all ribs become exactly alike, for already the smallest deviation can offer the greatest difficulties in assembly. After all ribs have been made in this manner, then the straps are also set in, on the rear side, and the points of junction are covered over with plywood. This work is naturally considerably simpler, since the ribs are already completed in their exterior shape when they are removed from the pattern.

The entering edge of the ribs, located ahead of the front beam, consists of a small piece of spruce of the strength of an average girth dimension (3/16 in.), which fits exactly into the girth and is covered over on both sides with the thinnest plywood (3/64 in. or thinner). In order to save in weight, the center portion may be sawed out in circular shape. The ribs of the transversal rudders are made exactly as the main ribs; however, those straps which later have to take up the beams of the transversal rudder (the second and third straps back of the rear beam) are not covered over with plywood. At these places the straps are merely fastened temporarily by a slight nailing, since these straps are to be replaced by the beams of the transversal rudder, following the construction of the wings. Only after the assembly and the setting in of the beams of the transversal rudder, is the superfluous piece of the lower girth which is marked with a dotted line in the drawing, and the upper girth cut through, whereafter the finished transversal rudder can be removed. The auxiliary ribs, which serve merely for maintaining a better profile or shape, have a free-carrying or unsupported end, which because of its elasticity exerts a pressure upon the covered supporting surface and hereby holds the covering of fabric tight. All told there are therefore 18 main ribs and 18 auxiliary ribs to be made, whereby the restrictions made on the four main ribs for the linking on of the transversal rudder must be considered, and whereby on 6 auxiliary ribs the free end is also discarded in respect to the design of the transversal rudder. Also still to be made are the two rear rib pieces for the inside closing off of the transversal rudders.

When our work has progressed this far, we start with the making of the beams (1). The front and rear beams consist of two vertical spruce boards for the sake of simplicity, which, as already mentioned elsewhere, must be entirely free of knots and whose grains must run parallel to the beam. Naturally these beams become considerably heavier than the originally intended beams of I-shape with a plywood strap, so that the total weight of 75 kilograms or 165 lbs. cannot be adhered to. An additional weight of a few kilograms or pounds plays no big role, in any event, and the boards, merely set on edge, simplify the structure considerably and permit easier repairs. The profile or shape which leans towards the customary profiles of sailplanes, has been so developed that the load to be taken up is distributed uniformly over the front and rear beams and at the same time possibly the greatest height of the beam is attained. The uniform distance of the beams from the center of pressure is the reason why the transversal rudder cannot be hinged to the rear beam; though because of this fact certain additional work is brought about, which, however, can be taken into the bargain in view of the advantages of the greater height of the beam. In making the beams, care must be taken that the upper edge of the front beam recedes in height to the front and the upper edge of the rear beam to the rear in correspondence with the shape of the ribs. Self-evidently the beams must also be planed smooth in order to assure a good gluing of the ribs and diagonals. The exact position of the middle lines of the individual ribs is marked upon the beams by aid of a square, and the holes for the beam fittings are drilled at this time, since this would be done with difficulty after the assembly has been made. Care is to be taken that the holes are drilled not larger, but rather somewhat smaller than required by their corresponding bolts, for the fittings, which for the sake of simplicity of construction, consist only of smooth sheet plate, can meet lasting requirements only when they fit unmovably tight.

The making of the nose beam (7) will probably not be possible for most of the sailplane builders for lack of suitable tools. This beam may be suitably cut in a machine-operated joinery, in accordance with the drawing. The rim bend is bent from several small individual lists over a pattern and glued together. The simplest way is this: The individual lists are covered with glue, bent over a suitably cut board edge and then nailed tight. After complete setting or hardening (24 hours) the rim bend which now will retain its shape, is removed and then worked further according to the drawing. At those places at which it comes in contact with the nose beam

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there takes place a gradual adjustment of the cross-section of the nose beam to the dimensions of the rim bend. The shafting or splicing point should be about ten times longer than the thickness of the rim bend. The rim bend should decrease gradually in thickness towards the rear edge of the transversal rudder.

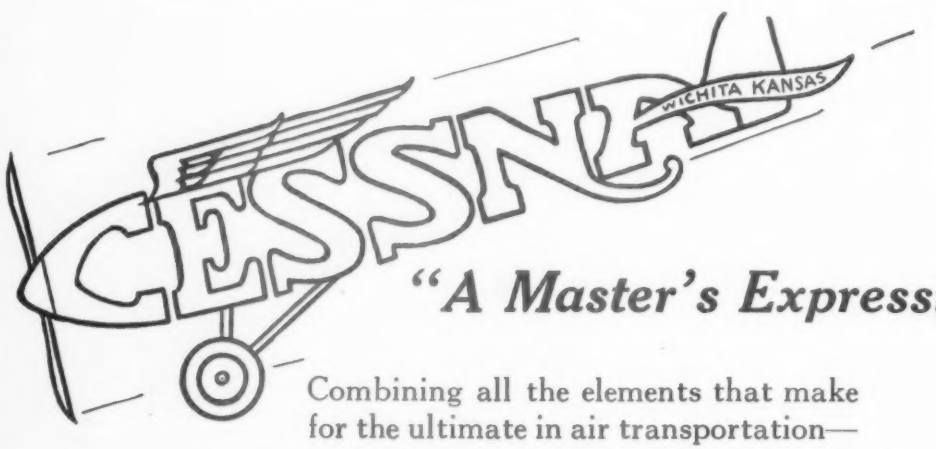
After we have progressed thus far, we place the beams upon two wooden horses and slide the ribs in their proper sequence over the beams. Here special care is to be used so that the straps of the ribs are not damaged. At the places which were marked previously, the ribs are now glued to the beams and nailed by light wire pins through the straps. Under no circumstances must nails be driven from above or below through the girths into the beam, for then the rib will break at this point under any small strain.

When each main and auxiliary rib is located in its intended position, we start with the making of the diagonals. A pattern is not necessary for making these, since they are merely made as right angles and triangles. However, it is recommended that the builder remeasure the necessary lengths since small deviations in building are not always avoidable and the dimensions given in the drawings would then be no longer correct. It must also be observed that there is a deviation from the horizontal which is given in the drawings, whereby small deviations from the right angle become necessary. The diagonals between the beams are made of T-shaped girths and of right-angular spruce lists as straps, like the ribs.

When all these diagonals have been made (3), eighteen of them all told, they are built in. Each diagonal is carried through an auxiliary rib, and after an accurate fitting it is glued to the beams. The exterior straps are to be somewhat levelled off for this purpose, for otherwise a sufficient gluing surface is of course not obtained. For safeguarding at the sides, small corner blocks are also glued in. Now the four triangular diagonals (4) for the bracing of the end ribs at the inside of the supporting wing half and of the transversal rudders are set up, glued to the beam and rib ends, and the points of junction formed by the beam and diagonals or diagonals and rib ends are covered over with thinnest plywood in order to attain a still more rigid connection. The strength of these connections is responsible for the later torsional strength of the supporting wing and this again is indispensable for safety in flying.

Before the diagonals in the transversal rudders (5) are made and built in, we must start to install the beams of the transversal rudders in order to be able to separate this transversal rudder from the supporting wing, for until this stage they form of course a whole with the supporting wing. We remove carefully the two straps of the ribs which were fastened only temporarily and which are concerned only with the installation of the beams of the transversal rudder; and then we glue, along with a light nailing in the upper and lower rib girth, the spruce lists (6) shown in the drawing. The drawing shows well that three of these four lists must be brought to corresponding shapes before being set in. The ribs are let in, above and below, into these girths of the rudder beams, care being exercised, however, that the middle section of the rib girth is cut out to the width of the lists to be set in, in order not to reduce the strength of the girth of the rudder beams too much.

If we have advanced thus far, then we set fitting straps between the upper and lower beam girth and for this purpose we use the same kind of material. Also, at this time the two end rib pieces which we have prepared especially for the transversal rudder, are glued in in order to effect an interior finishing off of the transversal rudder. Now we make the four diagonals of the transversal rudder (5) which, like the other triangle diagonals, consist merely of a triangle of lists with plywood glued on one side and nailed down.



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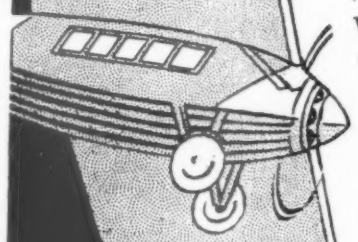

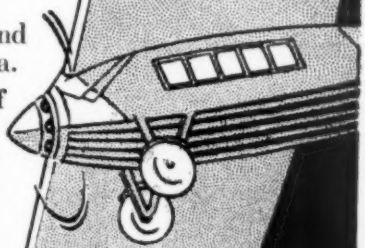

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After these diagonals have also been glued in, reenforced with corner blocks, and covered or lapped over with plywood angles, there comes the building in of the nose beams and of the rim bend. Due to the arching of the profile, a covering over with plywood at the nose beam is difficult. Therefore we satisfy ourselves here with the glueing in of corner blocks of somewhat greater dimensions, which, however, must be adjusted to the inside shape of the nose beam. If rim bend and nose beam and also rim bend and beams are connected with each other, then the rim bend is connected with the beam girth of the transversal rudder, that is, glued down with corner blocks and covered over with plywood. The ending beam girth must be drawn together to the middle in order to come upon the cross section of the rim bend. It may be repeated here once again, that the glued parts, particularly if no nailing is done at the same time, must remain about 24 hours under the pressure of a clamp.

(To be continued)

AUTHOR'S NOTE: Any queries of a technical nature in regard to these articles on sailplanes should be addressed to the author in care of AERONAUTICS.

List of Materials for Supporting Wings

Quantity	Parts	Number *	Material	Cross Section, in.	Length, in.
4	Wing beams	1	Spruce	7 3/8 x 15/32	219 1/8
18	Main ribs	2, 2a	Spruce		63 1/8
	T-girths			9/16 x 3/8	
	Straps			3/8 x 3/16	
18	Auxiliary ribs	2b	Spruce	9/16 x 3/8	49 3/16
	T-girths			3/8 x 3/16	
	Straps			9/16 x 3/8	
18	Beam diagonals	3	Spruce	3/8 x 3/16	35 1/2
	T-girths				
	Straps		Spruce	1/2 x 1/2	
4	End diagonals	4	Plywood	3/64 x 7 3/8	35 1/2
	Girths				
	Straps				
4	Transversal rudder diagonals	5	Spruce	1/2 x 1/2	32 3/16
	Girths		Plywood	3/64 x 7 3/8	
	Straps				
4	Transversal beam girths	6	Spruce	9/16 x 3/8	35 15/16
2	Nose beams	7	Spruce	2 1/2 x 15/32	207
2	Rim bends	8	Spruce	3/4 x 9/16	87
2	Straps for transversal rudder girths	9	Plywood	7 5/16 x 3/64	71 3/8
2	Straps for transversal rudder girths	9a	Plywood	8 x 3/64	71 3/8

Pieces of plywood are also for the making of the angles covering the points of junction.

* These numbers refer to corresponding numbers in the drawing.

On page 78 will be found construction drawings of the wing of the Gymnich schooling sailplane described here.

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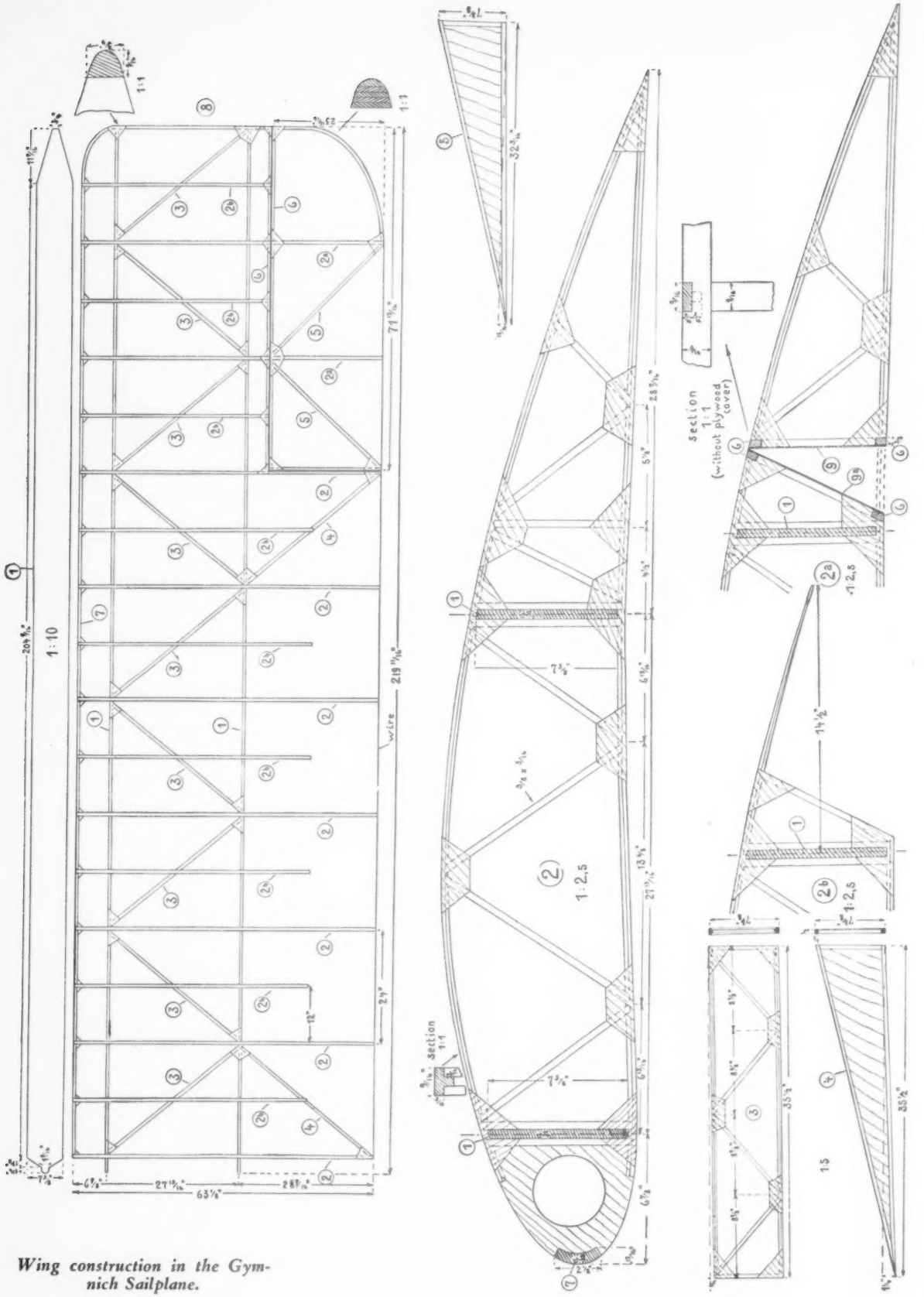

Wing construction in the Gymnich Sailplane.

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ON JUNE 9, 1928, the Elm Aviation Club of Buffalo bought a new OX5 WACO 10. Up to January 5, 1929, "it was flown over 300 hours . . . was landed over 2,000 times . . . has soloed 9 students. It has stood up well under tremendous abuse . . . today it's in very good condition." This is the report of Michael F. Steffen, manager of flying operations. He makes a statement typical of WACO users everywhere when he says, "I do not believe that we could have chosen a better airplane for our work."

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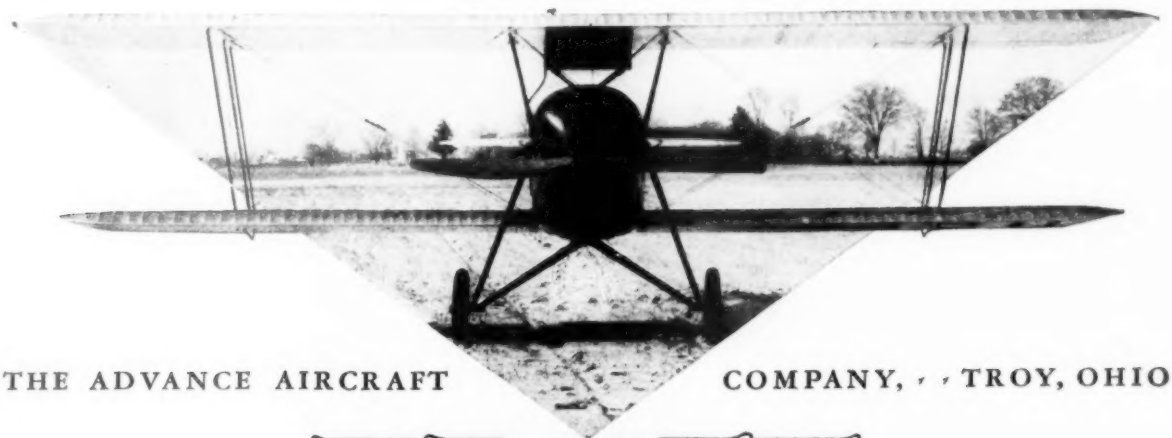

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Financial Review

By J. Allen Grover
Pynchon & Co., New York City

THE past month has seen a renewal of activity in financing operations in the aviation industry. Some interesting developments have taken place, including the formation of new companies and the appearance of an aviation finance company.

Aircraft Securities Corporation: Formed in January with a capital of 40,000 shares of common stock, this Delaware corporation is the latest addition to the Aviation Investment Trusts. Although the powers of the company are broad as described in the articles of incorporation, it is understood its business will be confined to acquiring and trading in the securities of both domestic and foreign companies engaged in different branches of the aviation industry.

On January 31st, Hoffman & Company of Dayton, Ohio, offered 2,000 shares of the no par common stock at $25 per share.

Aviation Credit Corporation: This is the first company formed to finance installment sales of airplanes and is certainly an indication of how the industry is benefiting from past experiences of other manufacturers.

Financing companies were unknown in the early days of the railroads and the automobile. Whatever may be the future of installment selling, there is no question but that in its amazing development in the last ten years it has aided every industry which has developed it, particularly, of course, the automobile industry. Aviation is a young industry already showing signs of great promise, but still in its most dangerous age. It is in a good position to adopt a proven selling method unknown to its predecessors.

Aside from the actual good which may result from installment selling of aircraft, the prediction is coming true that aviation has so many examples and precedents of other industries to follow that there is no reason for it to suffer as severely as other lines have suffered during the expansion period.

This pioneer company was financed by a group headed by Hayden, Stone & Company which offered on February 6th, 250,000 shares of no par common stock at $23.50 per share. There are 250,000 more shares authorized but unissued, of which 150,000 are under option at $23.50 a share until February 1, 1934. The company will have working agreements with Wright, Curtiss Flying Service, Inc., Keystone Aircraft and the Travel Air Company. The actual credit and collection details will be handled for the company by the Commercial Credit Company of Baltimore, who will receive a fee for actual business done and an unnamed interest in the profits of the company. Richard F. Hoyt of Hayden, Stone & Company is Chairman of the Board and H. L. Wynegar of the Commercial Credit Company of New York is President.

The Dayton Airplane Engine Company: Frear & Company of New York offered on February 18th, 40,000 shares of no par common stock of this company at $16.50 per share. This company is a new Delaware incorporation, and is the outgrowth of a private enterprise known as The Dayton Airplane Engine Company, which has been manufacturing aircooled airplane engines since 1927. The company has agreed to make

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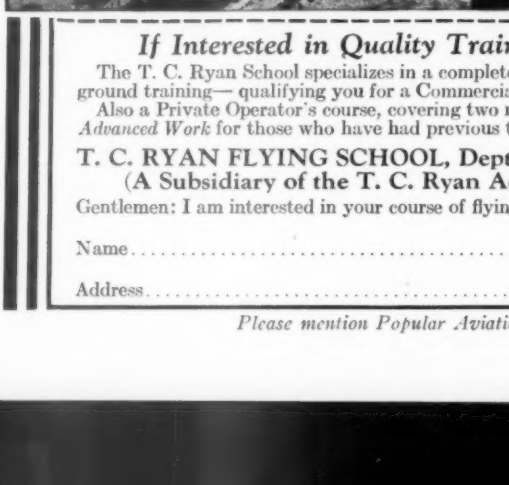

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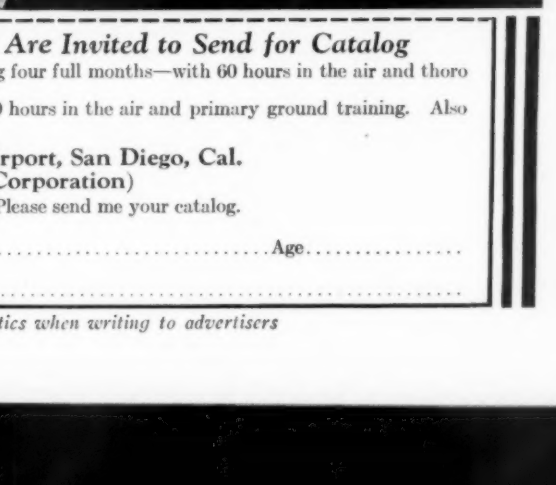

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Philadelphia Air Terminal, Inc.: This project was in the news several months ago and contemplated the acquisition of 175 acres of land at Pattison Avenue and Fifth Street, Philadelphia, within three and one-half miles of the main Post Office. The company was organized in Pennsylvania, and Orton, Kent & Company of New York planned to market 184,000 shares of no par common stock at $15 a share, but the stock was never issued and the bankers now advise that the plan has fallen through.

In a decision recently handed down in a suit regarding the legality of a municipal bond issue for the purpose of providing funds for an airport, the Supreme Court of Missouri declared that airports were comparable to harbors, and, therefore, were municipal, state and federal responsibilities, and that the issue in question was legal. This was a healthy decision for the aviation industry. It would be unfair to condemn all privately owned airports, as certain special local conditions might make it desirable, but in general it is certainly for the best interest of aviation to have airports, like harbors, operated by a disinterested agency for the common benefit of all.

Consolidated Aircraft Corporation: On January 31st, Pynchon & Company of New York offered and sold 82,175 shares of no par common stock of the company at $25 per share. The transaction does not involve new financing for the company, but it is the first opportunity given the public to acquire an interest in the concern.

The company was formed in 1923 under Delaware laws to construct and sell airplanes. In every year since 1924 it has shown a profit, and in 1927 and 1928 the net earnings, after all charges, amounted to over $1.50 per share on the stock now outstanding.

The company has 750,000 shares of no par common stock authorized with 550,000 shares outstanding. The purpose of this transaction was to establish a broad market for the stock, which will be listed on some recognized exchange. The business of the company until now has been, mainly, the construction of aircraft for the United States Army and Navy, where the planes have found high favor. It is now planned to increase production capacity and manufacture for the commercial field, though in no way will this interfere with the company's business with the Government.

The latest product is a giant flying boat built for the Navy and recently successfully tested, which will be used as a model for a passenger ship for the commercial trade.

Consolidated Instrument Company of America, Inc.: This company has lately been reporting substantial orders from prominent manufacturers and an extension program is evidently under way.

On January 18th, Myron S. Emery & Company offered 55,000 shares of no par common stock at $12.50 a share. The proceeds of the sale of 45,000 shares are to be used to acquire Julien P. Friez and Sons of Baltimore, manufacturers of aviation instruments and the Molded Insulating Company of Mt. Vernon, manufacturers of Bakelite Products used in connection with aviation instruments. Shortly after this financing was accomplished, stockholders authorized an increase in capital stock from 100,000 no par common shares to 200,000 shares. The stock is currently quoted "over-the-counter" at 17 bid, 19 asked.

Curtiss-Caproni Corporation: This company, whose formation was reported last month in these columns, has now entered the market with an offering by G. M. P. Murphy & Company of New York on January 23rd of 200,000 shares of no par common stock at $12.50 a share. The authorized capitalization is 1,000,000 shares of which 400,000 are presently to be outstanding. 100,000 shares are under option at $12.50 per share until February 1, 1934, to the organizers of the Corporation. The shares are currently traded in over-the-counter at 14 bid, 16 asked.

Pennsylvania First National Corporation: This company was heretofore known as the State Bankshares Holding Corporation. It was formed with the

(*Continued on page* 91)

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Evolution of the Diesel Engine

By Maurice Victor *

It is interesting to know what foreign technicians are doing with heavy oil motors; in particular, the Junkers motor presented by Peugeot at the Foire de Paris which seems to mark a very definite step towards lightness.

THE development and possibilities of aviation are such that it seems difficult to say that anything new of a technical or industrial order is not susceptible of interest in connection with aerial navigation.

This is true in particular for the Diesel engine and while this type of power plant does not present any immediate possibilities of application to the airplane it is interesting to record the appearance on the French market of a Diesel-Junkers motor, built under license by Peugeot and destined to equip heavy trucks.

The motor is no longer a stationary industrial motor with a low working speed but a realization of a long cherished engineering ambition that turns 1,200 revolutions a minute and which is able to compete with the motors of trucks in so far as their weight and flexibility are concerned and which possesses a great superiority in economy of operation. The combustible used in the Diesel-cycle is, in fact, heavy oil, a gas oil of low price which represents 60% of the products of the distillation of petrols. Several figures will show this economy well enough. The same truck of four tons and a half, with an ordinary motor has consumed 35 litres of gasoline to the 100 kilometres costing 56 francs, while with the Diesel-Junkers motor it only consumed 18 litres of gas oil making a cost of 10 francs and 80 centimes.

These considerations of price have not yet intervened for the exploitation of the airplane. However, another point is still to be considered, namely, the economy of the weight of the combustible realized by the use of the Diesel type motors whose thermodynamic efficiency permits the obtaining of consumptions varying from 175 to 180 grammes to the horse power against 240 grammes for gasoline motors. For an airplane of 2,000 H. P. which must fly ten hours, this benefit corresponds to a reduction in weight of 1,300 kgs. of combustible, without taking into account another gain in weight resulting from the decreasing of the capacity of the gas tanks which will have to have the minimum of weight for a combustible of high density, that is to say, occupying less space than gasoline.

Furthermore, it seems that this motor of the Diesel type will offer a greater security because of the elimination of delicate organs such as the carburetor and magneto, and also because the combustible is non-inflammable.

On the other hand, this type of motor seems to increase the weight of construction by reason of the increased coefficient of security that it is necessary to give it in order to escape accidents liable to result from the explosion of the carbureted mixture.

As one views it, the problem is of importance and it is prudent not to risk assertions either for or against the adaptation of the engine to aircraft since progress in metallurgy or a better use of materials will tend to make all such statements premature. It is expedient, therefore, to examine attentively what has been done in this variation of ideas and to draw non-partisan conclusions.

In order to appreciate the evolution of the Diesel engine toward a reduction in weight and the increase of normal working conditions it should be noted that in 1913 the average weights of these motors reached 70 kgs. per horse power. By a simplification of the construction and by doing away with the compressor, 24 kgs. per horse power was obtained in 1921. In 1927 Herr Junkers, thanks to research work on the construction and to thermodynamic efforts in the laboratory founded by him in 1900 at Aix-le-Chapelle, (Aachen) secured a heavy oil motor which weighed only 6½ kgs. per horse power, which brought it closer to the weight of the ordinary automobile motor.

The system utilized by Herr Junkers is very original in the sense that it permits the obtaining of an expansion approximately double that of ordinary motors, that it eliminates the strain on the bottom of the cylinders, that it takes weight off the bearings of the crank case, that it allows the lightening of the gear casing and that it offers a good balance to the movements of the parts of the motor.

The motor of two cycles has one cylinder in which are arranged two pistons, at the upper and lower ends. The lower piston is attached by a connecting rod to the central elbow of the crankshaft. The upper piston is connected to lateral cranks by two long connecting rods which work in traction at the moment of explosion. In the upper part a flat surface serves to guide the piston and form to compress air. A pump compresses the

* French Aeronautical Engineer, in a recent issue of Les Ailes, a French weekly aeronautical revue published in Paris.

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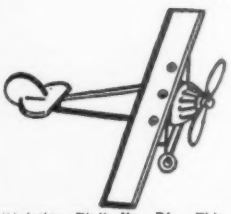

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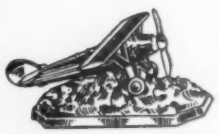

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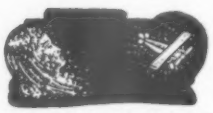

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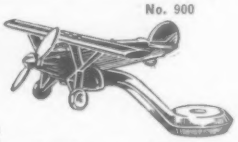

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This motor which starts cold on the gas oil seems to have a brilliant future. It is even said that a powerful and light type is expected to be realized soon in view of the dimensions of the industrial motor. It will be studied at Dessau (the Junkers headquarters in Germany). The motor is expected to give 200 horse power for a weight of 1 kg. to the horse power at a speed of 2,000 revolutions per minute and with a consumption of 175 grammes of heavy oil to the horse power hour. These specifications are furnished subject to the usual reservations.

Another German motor, developed by Korting, another great Diesel motor specialist, seems to possess equal possibilities. This is a motor of 6 cylinders in line, of 4 cycles without a compressor, with a gear case in light metal and a cam shaft driven by spur gearing. Each cylinder has two valves; the bore is of 130 m/m and the stroke 180 m/m.

At the commercial working rate of 1,200 revolutions, this motor develops 90 horse power for a consumption of 200 grammes of heavy oils and 6 grammes of grease oil (probably castor oil). The weight of the motor with its fly wheel is 1,000 kgs. which is still far from the proper figure for an application to the airplane, but it is hoped that this may be materially reduced.

English engineers, in particular Beardmore, have studied the Diesel motor also, but with the immediate end in mind of adapting it to aircraft. It is said that a motor of eight cylinders in line of Diesel cycle has given good results on its trials. It will be known as the "Tornado Mark-1" and has a bore of 210 m/m with a stroke of 305 m/m which will produce 650 horse power at 1,000 revolutions a

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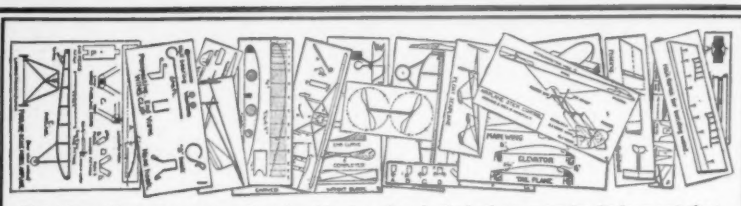

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Other countries are interested in the problem: Italy with Garuffa, the United States with the Eastern Engineering Company, the Packard Motor Car Company, and the Sperry Company. It is quite probable that in a short time with the constant progress that is being made in metallurgy and technique, the Diesel motor for aviation will become a reality.

The National City Company

(Continued from page 49)

miles of airways in 37 states in airplanes owned and operated by commercial concerns having contracts with the United States. Many of these planes carry passengers and express as well as mail.

The number of planes manufactured in the United States for commercial purposes in 1927 was 1,995. Their aggregate sales value was about $14,500,000. The number manufactured in 1928 has been estimated at 3,500 and it is believed that production in 1929 will reach a total of 5,000 or more. The sales prices of these commercial planes range from $2,000 for a small sport plane to $75,000 for a large tri-motor transport.

These figures indicate that aviation, as an industry, is not only well started but already on a solid foundation, backed by government contracts and growing rapidly. Such an industry could not fail to attract the favorable attention of banks and other financial corporations whose business it is to finance industries.

The banks are using air transport in their own business. It is stated that $24,000,000 now goes by air transport into New York daily, representing the face value of checks sent from all parts of the country to New York correspondents for deposit, loans on call, or other purposes. The air mail brings the checks to New York from one to three days ahead of train mail. The amount of interest saved, estimated at the low rate of 2% per annum, is said to total $144,000,000 per year.

The accounts of accidents published by newspapers give readers the impression that accidents to aircraft are numerous and costly. The fact is, on the contrary, that the proportion of accidents to miles flown by licensed airplanes in charge of licensed pilots employed by air transport corporations is small.

The United States Department of Commerce reports that 97¾% of licensed planes flew without a single fatality in 1927. During that year, ac-

cording to Government statistics, the proportion of pilot-passenger miles flown by mail planes to fatalities occurring in the air mail service was 1,414,000 to 1. In other words, the mail planes flew a distance equal to sixty times around the earth for each fatality.

The factor of safety in air transportation is so high that some of the foremost insurance companies are now writing, at reasonable rates, practically all forms of insurance covering hazards incident to airplane operation. All companies holding air mail contracts are required to conform to the Air Commerce Act and the regulations promulgated thereunder by the Secretary of Commerce of the United States, and this tends to maintain a high factor of safety.

The United States government is increasing the safety of the airways. Already 8,000 miles of air routes are lighted for night flying and more beacons are being installed each month. Progress is being made by the Bureau of Standards in developing radio beacon service for airways. A visual indicator has been developed for use in airplanes that will enable pilots to receive the signals from the radio beacons, keep on their courses and reach airports even when visibility is so low that beacon lights cannot be seen. The Weather Bureau is starting a service by which pilots in the air will be notified by radio telephone, at short intervals, of the weather conditions that they will encounter as they proceed on their courses.

The reasons why The National City Company selected, from the whole field of aviation, securities of Boeing Airplane & Transport Corporation as a safe and suitable investment for its funds are easy to understand.

Boeing Airplane & Transport Corporation will presently acquire 100% of the capital stock of Boeing Airplane Company, and these two companies together will own practically 100% of the common stock of Boeing Air Transport, Inc. The three foregoing companies will together own over 70% of the outstanding stock of Pacific Air Transport.

Boeing Airplane Company is one of the foremost manufacturers of airplanes in the world. Its plant in Seattle, Washington, employs about one thousand people. There are sixty-five engineers on its technical staff. The Company manufactured, from the time of its inception to the end of 1928, a total of 1,060 airplanes. The United States Army and Navy purchased 980 of these.

Boeing Air Transport, Inc., carries the United States Air Mail, as well as passengers and express, between Chicago and San Francisco. A daily service, each way, is maintained over this 2,000-mile air route.

The company commenced operation in July, 1927. By the end of 1928 it had

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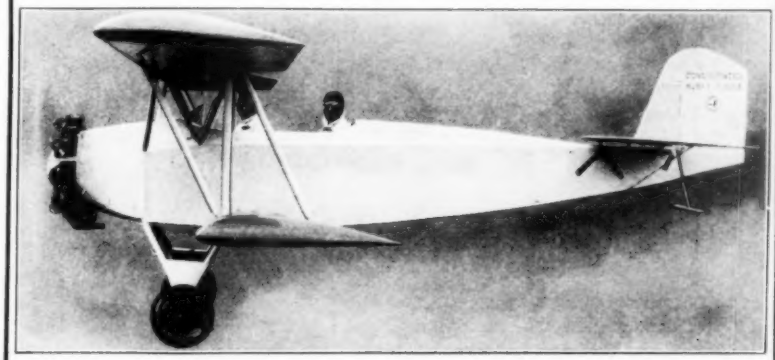

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26 mail planes in operation and had ordered ten more from Boeing Airplane Company. It expects to place twelve tri-motor passenger planes in regular passenger service between Chicago and San Francisco in 1929.

Pacific Air Transport carries the United States mail, as well as passengers and express, between Los Angeles and Seattle. It commenced operation in September, 1926, over this 1,100-mile route. Control of its management, through stock ownership, was obtained by Boeing Air Transport, Inc., in January, 1928.

The operations of these companies have been profitable. The combined net earnings of Boeing Airplane Company, for 1927, and Boeing Air Transport, Inc., for the last six months of 1927—the period during which it operated in that year—amounted to $201,937. For the first eight months of 1928 the combined net earnings were $592,905. This was equivalent to an annual rate of over three times the annual dividend requirements of the issue of preferred stock in which The National City Company invested. After deducting the preferred stock dividend requirement, the remainder would be equivalent to an annual rate of $1.00 per share on the common stock to be issued.

The $4,000,000 working capital and expansion fund to be set aside from the proceeds of the financing in which The National City Company participated will give Boeing Airplane & Transport Corporation additional earning power. The combined net earnings of Boeing Airplane Company and Boeing Air Transport, Inc., plus the Boeing Airplane & Transport Corporation's pro rata portion of the net income of Pacific Air Transport for the calendar year 1928 were estimated at $1,300,000.

The possible growth of the earnings and profits derived from air transport is extremely interesting to financiers.

Present contracts for carrying mail between Chicago, Iowa City, Des Moines, Omaha, North Platte, Cheyenne, Rock Springs, Salt Lake City, Elko, Reno, Sacramento and San Francisco give Boeing Air Transport, Inc., $1.50 per pound for distances of 1,000 miles or less, and fifteen cents per pound for each additional 100 miles.

Pacific Air Transport is paid at the rate of $2.81 per pound, on the route between Los Angeles, Bakersfield, Fresno, San Francisco, Medford, Portland and Seattle, for distances of 1,000 miles or less, and $3.09 per pound for distances over 1,000 miles and under 1,100 miles.

The air mail postage rate was reduced by the Post Office Department, effective August 1, 1928, from ten cents per half ounce to five cents per half ounce plus ten cents for each additional ounce. During the month of August, immediately following this reduction, Boeing Air Transport, Inc., carried 82% more air mail than in the preceding month. The natural growth of air mail volume, without any change in rates, was shown by an increase of 30% from January, 1928, to July, 1928.

The total weight of first-class mail carried in this country in 1928 was about 994,000 pounds daily. The 14,000 pounds carried daily by airplanes was only about one-seventieth of the total. With the advantage of low postage rates, the speed that saves interest charges, delays and losses in business, and a high factor of safety, it seems reasonable to suppose that the volume of mail carried by airplanes will increase steadily.

The National City Company did not offer stock of Boeing Airplane & Transport Corporation to the public. The stock that it purchased was sold prac-

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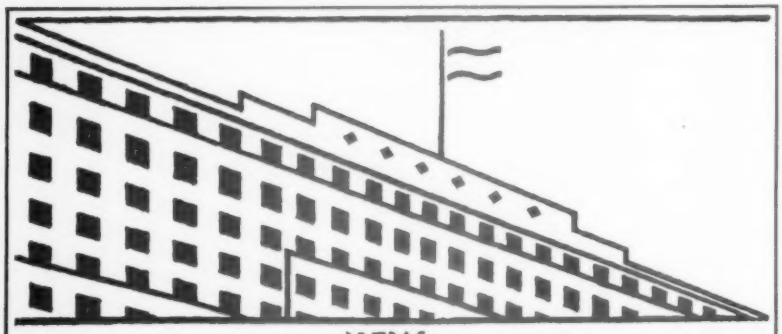

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tically entirely to officials and employees of the National City Company, and the National City Bank.

Financial Review

(*Continued from page 82*)

intention of dealing in stocks and securities of aviation and related industries, and now appears in the market with a public stock offering under the new name.

F. B. Wilcox & Company, Inc., of New York, offered on January 30th, $500,000 7% cumulative preferred stock of $10 par value and 50,000 shares of no par class A common in units of 1 share of each with common stock purchase warrants attached. The units were brought out at $15 and are quoted by the bankers at the same price at this time. The warrants are good until January 1, 1930, for 1 share of class A common stock at $10 per share and until January 1, 1931, for 1 additional share of class A common at $15 per share. An unusual feature of the offering was the ruling that not more than 100 units could be purchased by any one person, although smaller amounts could be applied for.

United Aircraft & Transport Corporation: On January 31st the National City Bank of New York offered 150,000 shares of 6% cumulative preferred stock, series A, and 60,000 shares of common stock of the above company in units of 10 shares of the preferred stock and 4 shares of common stock at $1,000 per unit.

This is not a new company but is the name adopted by the Boeing Airplane and Transport Corporation and affiliated companies. This includes, besides the Boeing Company, the Chance Vought Corporation, the Hamilton Metalplane Company, the Pratt & Whitney Aircraft Company, and the Hamilton Aero Manufacturing Company.

The purpose of the issue is to provide additional working capital which will be expended in the elaborate expansion program laid out by the directors.

The preferred stock carries with it non-detachable warrants entitling holders to purchase, up until November 1, 1938, common stock of the company at $30 per share at the rate of one share of common stock for each 2 shares of preferred stock. This financing represents the largest consolidation on record in the history of aviation in America, and the resulting company will rank in resources and financial backing with the most powerful companies in the field.

During the month before going to press the stock market has shown conflicting movements which have, of course, been reflected in the prices of aviation securities. During the last two weeks of January and the first days of February, prices were firm with a trend to higher levels. Then a peculiar set of circumstances, including a warning from the Federal Reserve Board to the stock market, and a 1% increase in its rediscount rate by the Bank of England, brought about a sharp decline which threatened for a few days to become drastic. The market recovered fairly well but at the present writing there is an uncertainty prevalent which is causing a drift to lower levels.

The quotations below give the high for 1929 and the current prices of aviation stocks on the New York Stock Exchange and the New York Curb Market:

	1929 HIGH	*CURRENT*
* Curtiss Aeroplane & Motor Co.	173½	149
* Wright Aeronautical Corp.	299	258
** Aviation Corp. of America	55⅞	52⅞
** Bellanca Aircraft Corp. of America	23⅜	17
** E. W. Bliss Co.	57⅞	43¼
** Boeing Airplane & Transport Corp.	99¼	87⅝
** Curtiss Aero Export	51½	45⅜
** Curtiss Flying Service, Inc.	25	22

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(PA-4)

** Douglas Aircraft Co., Inc.	30⅜	25⅜
** Fairchild Aviation Corp.	34⅞	28
** Fokker Aircraft Corp. of America	27⅜	25
** Keystone Aircraft Corp.	50	40⅞
** National Aviation	72⅜	67⅞
** Niles-Bement-Pond	230⅜	217⅞
** North American Aviation	19	15½
** Sikorsky Manufacturing Corp.	44	37⅝
** Transcontinental Air Transport	30	24½
** Travel Air	61	55¾
** United Aircraft & Transport Pfd.	...	88
** United Aircraft & Transport	97⅜	87⅝
** Universal Aviation	26	23¼

* New York Stock Exchange
** New York Curb Market

Weather System

(*Continued from page* 70)

flight from the operations manager of the Transport companies.

Experimental operation of the new weather communications system was started on November 1, 1928. The radio stations at Hadley Field, Bellefonte and Cleveland, installed by the Airways Division, are now ready for service operation and the airplanes of the National Air Transport, flying the mail between New York and Chicago, have been equipped with receiving sets for this service. The experience gained this winter will provide the basis of the service required for the safety of passenger lines which will be started next spring.

Before taking off, the pilot refers to previous weather reports and notes especially any orders from the operations manager concerning the scheduled trip. After taking off, the pilot receives hourly reports on landing conditions and Weather Bureau forecasts. If landing at the terminal field becomes impossible, reports on intermediate fields along the route and alternate terminal fields permit the pilot to land safely and await more favorable weather. The operations manager follows weather conditions closely and advises the pilot regarding his judgment of conditions and transmits such orders as are found necessary for the proper protection of the interests of the Transport Company. Arrangements made for motor or rail transportation of passengers and mail, if landing is ordered at a field other than the terminal, can be communicated to the pilot so as to provide for the comfort and safety of the passengers and expediting the mail. Circumstances may require flying at high altitude over ground fog on radio-range signals over the airway, or flying blind by instruments through thick weather, and this may be done with safety as long as the pilot is kept advised that landing conditions are safe at the terminal field, or at some other specific landing place. Many trips now lost will be completed with safety as soon as this comprehensive weather communications service is established.

The Southern Cross

(*Continued from page* 66)

soon became embarrassingly inadequate, and at last when the Government of New South Wales expressed a desire that the plane be sold and the flight abandoned, the airmen agreed to give up the project. At this discouraging moment Capt. G. Allan Hancock became interested in the affair, and ultimately bought the big Fokker himself, turning it over to Ulm and Kingsford-Smith for the Pacific flight, and finally deeding it to them altogether.

Once the flight had become an actual possibility the flyers set about the great task of preparation in earnest. The most complete plans that could be drawn up were made, and every possible contingency was provided for so far as might be. Probably no flight has ever had more minute and painstaking care bestowed upon its planning. The equipment to be carried was selected, installed, and inspected with an appreciation of its importance which was never for a moment permitted to relax. The flight was planned to succeed, not to muddle through, and it stands therefore as an achievement for which intelligence, will, and courage, and not the law of averages, were responsible.

The book is valuable not alone as the first-hand story of this extraordinary

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flight but as the record of what must in the very nature of things always be the method of aeronautical achievement. It is a stimulating and powerful story of solid accomplishment.

Survey of Stocks

(*Continued from page* 38)

tion Securities had a smaller amount of stock outstanding 150,000 shares as against National Aviation's 180,000 shares, and also that it had shown a faster earning capacity. And as National Aviation could be marketed for around $66 a share the proceeds would buy more than two shares of Aviation Securities, selling between 31-33, with the probabilities that the market price of Aviation Securities within the near future would come much nearer to that of National Aviation.

North American Aviation (an Investment Corporation) was organized on December 6th. In 3½ weeks it paid off $35,000 of organization expenses, and showed a net profit of $8,858, and an appreciation in values of investments of $510,400.

Aeronautical Industries, another stockholding company, showed appreciation in investments as of Jan. 31, of $137,827. This company was organized in July, 1928. Its capital structure is 500,000 shares (no par) authorized. 60,000 shares have been issued. An additional 40,000 shares is to be issued and some new strong interests including J. C. Willson, J. Cheever Cowdin, and Leonard Kennedy are to be associated with the company. Market 20-22.

Aeronautical Briefs

1. Fokker Aircraft, as an indication of its continued expansion has just issued an order for 350 airplane motors, amounting to $2,400,000. This is divided between Wright Aeronautical Corporation, and Pratt and Whitney. Market 26-26½.

2. A Japanese Transport company is slated to begin its services on April 1st. The fare between Tokio and the terminal, 250 miles, is at the rate of 6.8 cents per mile. The very modest fare is due to a Governmental subsidy. The train distance between the two points is 13 hours. The plane saves almost 10 hours. As against this modest fare the Hudson Bay route in Canada bases its rate on time saved, rather than on distance covered. The fare is $3 a mile between Ft. Churchill and Le Pas, and in Colombia, South America, the rate between Bogota, and the Coast is only a trifle less than $3 a mile.

3. Capt. Herman Koehl, and Major J. C. Fitzmaurice, the Transatlantic flyers, are to fly mail across the Atlantic for the Luft-Hansa of Germany, according to the latest reports from Berlin.

4. Consolidated Instrument has increased its capital of 200,000 shares, of which 175,000 will be outstanding. Stock sold at $10 a share around the first of the year, and is now quoted 25-25½. Listing on the New York Curb is expected this week.

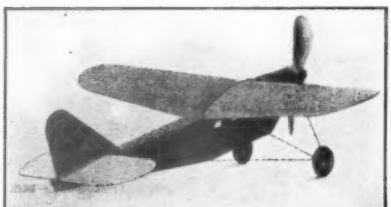
5. Stearman Aircraft. Earnings for the last quarter of 1928 were $38,460 or 3% on 12,500 shares outstanding, which is at the rate of $12 per annum.

6. American Airports was selling around $50 a share on January 1st, and is now quoted $95-$100. The directors include William B. Mayo, Chief Engineer of the Ford Co., George Mixter, Vice-President of Stone and Webster. Services were required on a number of prominent airports including Newark, N. J.; Philadelphia Air Terminal; Pinehurst, N. C.; Springfield, Mass.; Columbus, Ohio; and others, and will be required shortly in connection with the Toronto airport. Authorized capital is 10,000 shares of which approximately 3,400 are outstanding.

7. Travel Air, for 1928, showed net income of $360,932, after deducting federal taxes, depreciation, and all other charges. This equals $3.60 per share on the outstanding 100,000 shares. It is reported the company sold 535 planes last year. Total volume of sales $2,229,000, as against $641,000 in previous year.

8. National Air Transport has flown 2,138,183 miles in 1928, has carried 1,126,067 pounds of mail, 72,380 pounds of express and approximately 13,000 passengers.

9. Major activities of the Chicago municipal airport in 1928 were: Passengers carried 30,206. Total air mail 1,688,887 pounds. Visitors 998,279.



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POPULAR AVIATION IS NOW AERONAUTICS

Permission has been requested to land amphibians in the Chicago Harbor.

10. Four motored Dornier Superwal flying bombs with engines mounted above the body of the crafts will be used on the daily schedule of the Detroit and Cleveland Navigator Co., between Buffalo and Detroit; and between Buffalo and Cleveland.

11. One of the best known economists in the country points out that China, India, and other densely populated foreign countries could not buy automobiles, because they lacked highways but such countries need no highways for airplanes and planes will be their salvation, he suggests. He further remarks that Curtiss Aero Export is one of the best equipped companies to profit by this prospective business.

Aerial Navigation

(*Continued from page* 34)

any time when one is doubtful of the behavior of his compass.

At 4,000 feet aerial beacons will be picked up 60 or 70 miles away and a good fix can be obtained without the waste of time spent in "closing them."

One more word on bearings before we get on to real sky-piloting aerial astronomy, and this has to do with radio beacons and bearings.

The operation of these, is in this radio age pretty well understood and is applied with equal success to ships and planes. The radio beacon transmits standardized signals the direction of which can be picked up by planes fitted with directional gear. The D. F. station carries out the opposite function and picks up signals from air craft and transmits a bearing back to the craft in question. Radio holds great promise of becoming a primary aid to aerial navigation and soon planes will be taking radio cross bearings and angles ad lib. Visual indicators for radio directional work are gradually being improved and with every improvement the popularity of radio navigation increases with the pilots who have never, as a class, taken kindly to radio headgear.

With the increase of the size of planes, a silent box for the navigator is by no means impossible, and then with a good D. F. set and plenty of stations he could lay off a continuous line of angles and bearings without reference to earth, sun, moon, stars, etc. This is, of course, true, provided always there was no interference or radio failure. Developments along these lines are coming fast. The author assisted with some very early experiments with D. F. for marine uses and is a firm believer, that therein, to a large extent, lies the secret of really successful blind flying.

Aerial Mapping in Mexico

(*Continued from page* 22)

to find that this solid phalanx of clouds was massed over the district, making camera work impossible. A careful study of the movement of these clouds, however, seemed to indicate that they followed a certain schedule, and the flyers determined to arrive over the district at a different period of the day.

The next morning Bonnick and Snyder took off an hour before dawn, and upon their arrival found a cloudless sky, enabling them to get in an hour of excellent photography before the vanguard of the cloud parade closed in below him. He had found the secret of this cloud movement to be as follows: in the period immediately following sunrise, the southwest winds off the sea would force the masses of haze which hung along the shore upward and inland. As they progressed the heat of the land below would cause them to rise until they encountered the northwest winds always present at altitudes of 15,000 feet and above, whereupon the clouds would reverse their direction and be blown off to sea again. This constant going and coming left Bonnick only about two or three hours of the day when conditions were favorable for high-altitude photography. It necessitated a take-off with the stars twinkling in the sky, when he and Snyder would grope their way sleepily toward the plane and only be roused into wakefulness by the appearance of flame gushing from the exhaust ports of the motor, plainly visible in the darkness, though invisible in daylight. An hour's stiff climbing took them to an elevation of 18,000 feet over their territory; then an hour's camera work before the clouds made further efforts useless. A second trip would be made in the afternoon, terminated by the usual parade of clouds about three p. m.

This time-table regularity did not always hold true. There were some days, foggier than usual, when the clouds never parted for a moment. Again, there were four days when not a single dot appeared on the sky. During these four days the two men were in the air a total of 22½ hours, covering 1,800 square miles; flying strip after strip, back and forth over the dense jungles and swamps far below, allowing themselves a slight grin when they gazed at the laborious path cut through the underbrush so near and yet so far from that dry river-bed which would have immensely simplified matters for the ground surveying crew. On the fourth night, Bonnick prayed for clouds. He thought he had earned a rest, and on gazing out of the window the next morning, was gratified to behold a pea-soup fog.

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During the short rest which was thus providentially provided, Bonnick was enabled to catch up with his developing schedule. He had no well-trained organization to turn over his film to, nor any assistants to do his laborious routine work of developing. In spite of the huge amount of film exposed in the course of his work, he not only did his own developing and printing, but also built up two "mosaic" maps of the district and furnished index maps for all the unmounted prints he produced. On cloudy days the local ice-plant nearly collapsed from the strain of producing the daily quota of ice, and Bonnick himself was forced to exert himself to the utmost to keep abreast of the camera's output of negative.

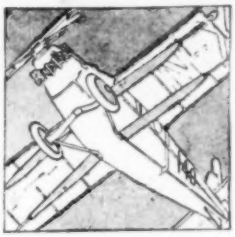
The 2,400 square mile territory was completed in 12 photographic flights, in an elapsed time of less than two months. Therein lies some comparison of the value of the aerial survey to the company's client, who had been hacking away at the jungle with his ground crew and peons for some weeks previously without accomplishing anything more than has been previously described. The cost per square mile was not only a small fraction of that which would have been expended on a ground survey and the time proportionately less, but in addition every feature of the territory was shown in the aerial map in its correct position.

At the conclusion of the actual mapping, several side trips were made between Tampico and Mexico City for the purpose of securing oblique views of the territory. Near Mexico City are the two twin volcanoes of Popocatepetl and Ixtaccihuatl. In the ancient Aztec days the latter was referred to as the "Sleeping Lady," and Popocatepetl is the scene of some of Mexico's most important history. The important and decisive battle between the Aztec emperor Montezuma and the Spanish invador Cortez took place on the lava sides of this extinct monster, which towers 18,000 feet above sea level, and which boasts a crater three-quarters of a mile across.

The now-extinct crater is the source of considerable sulphur which is extracted by the Mexicans and exported. Snow covers the upper thousand feet of the volcano the year round, and sometimes has been known to advance two thousand feet down its steep slopes.

Some excellent views of this historic spot were obtained by Bonnick and Snyder, two of which were presented to President Calles, who is reported to have hung them in Chapultapec Castle, the official residence of Mexico's chief executive.

Making any sort of a map in Mexico is no job for an amateur. In addition to



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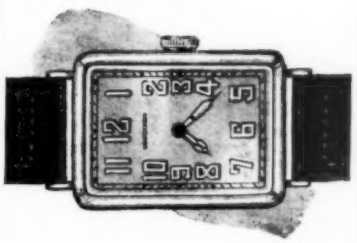

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the difficulties of transportation and communication, there are very few dependable maps in existence which can be used for reference or co-ordination in the way in which we use government geological sheets when mapping a part of the United States. This means that the map-maker is absolutely on his own; he has no previous data to go by, and no helps provided by the government. This is not, therefore, a task to be assigned to a beginner. Also, in making an aerial map, the extreme differences in temperature are a source of continual annoyance and discomfort. In preparing for a flight, Bonnick and Snyder were forced to encase themselves in heavy fur-lined flying suits and felt boots, and to remain bottled up in these fireless cookers in a temperature of 100 degrees in the shade while the motor was being warmed up on the ground. An hour's climbing would take them to 18,000 feet where this sense of oppressive heat gave way to a penetrating cold. Returning to the lower levels after flying their trips, they would find the gas tank, camera and all other metal parts streaming with water due to condensation. This sort of thing puts a severe strain on the flyer's constitution, which must be rugged enough to withstand such assaults.

The rigors of the climate and the exasperations of tropical life apparently have not been duly impressed upon Bonnick by this adventure. He has lately departed for Mexico again in a brand-new Fairchild monoplane, bound for the Isthmus of Tehuntepec, which is about as far into the Mexican sticks as this biographer can imagine anyone going. He expects to be gone several months and to repeat his performances in the neighborhood of Tampico, with variations. Moral: Aerial photographers rush in where surveyors fear to tread.

Tail Spins and Forced Landings

(*Continued from page* 14)

will become capable pilots can be selected. These men can be given exhaustive training which will prepare them for every emergency. Such training will cut to the irreducible minimum the number of accidents occurring to these men. There will be no crashes due to inexperience or lack of aptitude.

Such an ideal is not easy to attain, particularly in civilian schools where education rather than official authority must be depended on. Yet nothing could be of more value to the future of aviation than the development of the science of flight training. Flying is safe, but only for the man who has been trained to fly safely.

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Model Builder's Department

By Bertram Pond

The Use of Metal in Model Airplane Construction

METALS have found their place in big airplanes even to the extent of being used in the construction of bodies, wings and even the wing covering itself. It is a known fact that metal is stronger for a given weight of material than is wood, providing the metal parts can be made so that they will not bend. The only reason wood is used in small airplanes is because it is cheap and easy to work in the first place and because in the second place metal parts would frequently be so small that they would bend and buckle and double up even though they were strong enough in tension and compression. The wood for the same strength has a greater cross sectional area and does not bend. This is the reason why metal is found more often in large airplanes than in small ones. The metal parts in large planes are more often of cross section large enough so that they will not bend or buckle. By corrugating the metal or using a fine tubing and bracing the long members against bending the metal construction especially in the large airplanes can be made much lighter than wood.

Now let us see how we can use metals in our small model airplanes. Metal is easily worked and bent or hammered to any shape or form within reason. Small metal fittings, bearings, "S" hooks, washers, etc., are required even on the smallest skeeters and even "atom" sized models, as wood will not stand the strain.

It is true that we cannot construct a slow flying light weight model completely of metal or even make the framework of metal but it is the firm belief of the model editor, from the many models that he has examined, that it will not be long before scale models and compressed air models will use large numbers of metal pieces in the body and wings as well as in the landing gear and other members.

Some commercial models or manufactured jobs are made of metal. Among these is the Mocar Spirit of St. Louis monoplane model. This little machine is full of good ideas which it would pay any model builder to study. The plane is made altogether of fine aluminum strips fastened together with very small aluminum rivets. A simple squeeze with a pair of pliers is all that is necessary to assemble one of these riveted joints.

By properly corrugating and fabricating the metal parts of your large airplane model from thin gauged light hard aluminum you will be surprised at the very light and strong machine you can build. This metal construction is a new field for development in model airplane work and offers considerable in the way of interesting experiments to the model builder. Of course, to date, the large airplanes use about the thinnest aluminum obtainable for the covering of the wings so that it would hardly be practical for the model builders to attempt to cover the metal framework or wings with a metal covering. Outside of this, at present, metal construction offers a great field for model builders, especially on the larger scale and compressed air models.

Left to right, Shifler-Smith, Tiecotter, Lange, Weaver, and Pond ready to fly to St. Louis in Mr. Charles Dickinson's Breguet biplane.

Model Airplane Contest

Now is the time to get out your models and your model tools. From your experience in past contests if you are an old model builder you should try out and test all of the improvements that you have in mind and if you are a new follower of this interesting and instructive sport you should acquaint yourself with the best types of models which are used in contests such as the contest winners and world record models. Make the acquaintance of some local model builder and have him show you as much as he can.

Bigger and better things are in store for the model builders for the year 1929. This will be a banner year for model airplane activities. There will be contests and prizes galore.

In the next few issues of POPULAR AVIATION AND AERONAUTICS an announcement will be made regarding one of the largest model airplane contests ever planned. New, interesting and improved rules will be used in this contest. There will probably be events for compressed air driven models as well as rubber driven machines. You will have the time of your life at this contest and you should start preparing now so that you may win your local contest and have your record sent in for consideration for eligibility for the National events.

Don't wait for the announcement but get started now on your models and be a winner. The model editor does not want it to be said that you were not forewarned sufficiently in advance to fully prepare for the contest.

A Champion Flyer Speaks

The model department is in receipt of a letter from a most interesting model constructor—Mr. A. L. Jackson—a sailor on the Great Lakes and a great student and builder of model airplanes who writes us that he has built a Commercial Transport and a "C" model as described in the columns of POPULAR AVIATION AND AERO-

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NAUTICS, formerly Popular Aviation, and advises that these machines proved to be very simple to build and easy to fly. He made a flight of ¾ of a mile with his "C" model in the winter time at his home in northern Michigan. He also states that his commercial transport was one of the best fuselage models he has ever flown and that he made flights of considerable duration with this very interesting type of model.

We have received many letters telling us how simple the models described in the model section were to build and how well they flew after being constructed.

That is the aim of the model department and it seems to be well substantiated by the results the model flyers produce. National contests and important local contests have been won with the POPULAR AVIATION AND AERONAUTICS, Elliott and "C" models. The commercial transport has brought a new era in fuselage model flying. Ernest Marcoviller won one of the events for fuselage models at the Atlantic City contest using a machine quite similar to the Commercial Transport.

All of these models are the results of considerable development dating as far back as 1911 and we have tried in every case to give credit to the originators of the design and details which go to make the models successful.

How to Form a Model Club

We have received literally hundreds of letters from model airplane instructors and recreation directors for suggestions on the forming of model airplane clubs and the conducting of contests. The details of running a contest are often unforeseen until the time of the contest and much confusion often arises to the dissatisfaction of the contestants and its sponsors.

It is with this in view that the model editor has compiled the following suggestions and thoughts based on previous experience at model airplane contests. As many of these precautions and suggestions were learned only after irksome experience you would do well to carefully consider all of these suggestions in your program of club organization and model contests for the coming season. You will find that the clubs and the contests will run much more smoothly after these thoughts and suggestions are followed.

Suggestions for the formation of model clubs are given in the present article. Next month we shall include rules and advice for the planning and conduct of contests.

It is advisable wherever possible to form all the boys and young men interested in model airplanes into an organization if you do not already have one. There are hundreds of such organizations throughout the country and they all were formed and are operated on about the same simple plan.

To organize such a club it is not necessary to have a large number of model builders as it is quite easy to get boys interested in building models, especially when you tell them how easy it is to make models really fly and fly well using the light materials now available and the world record style of plans as published in the POPULAR AVIATION AND AERONAUTICS Model Department from time to time as well as in some of the other well known magazines. A model in a store window with a card announcing the first meeting of your proposed organization will usually attract a considerable number of prospective members. A demonstration at the local Boy Scout Troops, Hi Y Clubs, playground and recreation centers will have the same desired effects. If you can make a model fly quite well it has often been arranged to have a demonstration before the high school in assembly. Of course, announcements in the local newspapers will always be of some benefit in advertising the first meeting.

The first meeting should be very interesting and instructive to all of the visitors. A short and snappy talk by some local aviator or older model flyer will interest the boys immensely. Perhaps a short model demonstration can be included to make your meeting more successful. Then the purpose of the club should be explained. The purpose is to build and fly model airplanes and to study aviation through their use.

A simple standard set of rules and by-laws should be drawn up from the suggestions and decisions made at this first meeting. A set of officers consisting of a President or a Commander if you wish to make the club semi-military, a Vice President or Vice Commander, a Secretary, a Treasurer and a Contest Committee Chairman should be elected as soon as possible after the organization is completed. The officers should be selected not with the idea of their local popularity, wealth or any other similar reason but with the sole purpose of getting the best man for the office. If you want your model club to go over big as many of them have, you can not have a set of officers who will "pass the buck" as the saying goes. They must be "go getters." The ages of the members should be limited, perhaps, to about an absolute minimum of 8 or 10 years of age, or even 12. It is often advisable to classify the members into groups, especially if the membership exceeds 20.

You should not try to organize a club if you can only get 5 or 6 who are interested. The groups should consist of boys up to 16 years of age—Junior Group, and the Senior Group of young men from 16 years of age on up. I would

suggest that you do not limit the membership to 21 years of age unless it is insisted upon by a great majority of the boys as a boy over 16 years of age can compete on an equal basis with men over 21 years of age and yet the presence of men over 21 years of age in your organization is often a wonderful help because of their various experiences and abilities.

Arrange to have an interesting speaker at each meeting if possible. Figure your programs out several days ahead of time and see that they are carried out in an interesting manner. See that the meetings are not drawn out by long endless discussions as you will find that the parents often object to their sons remaining out too late in the evenings.

In order to have as large a number of members as possible attending each meeting you should have the Secretary notify every individual member in some form or another of the meeting. One of the best ways is to send each member a notice of the time, place and special features of the program on a government postal card, either blank or on printed form. The members should receive this card a day before the meeting as a reminder to them.

After the meetings and lectures on models have progressed and the boys have built a number of models you should begin to enforce the requirement that members who have not built models or do not intend to are no longer desirable unless they have some special talents such as executive or lecturing ability on aeronautics, models, etc. At certain meetings from then on, trial flights should be arranged as part of the program. The model flyers get a great "kick" out of these trial flights and they often turn out to be very interesting contests with the members wagering "cokes," sundaes, etc., on the performance of their models.

Later large contests can be arranged. The Kiwanis Club, Rotary Club, Commercial Club and other organizations and business men will not only be interested but will almost insist upon donating prizes for your contest. Of course, you should not solicit the aid of the business men until you have learned how to run a contest and how to build and fly models as you may want to solicit the aid of the business men again and you should make a good showing the first time. Be careful that your first contest is not for elaborate models. If it is, about half of the members will show up at the contest without models or with partly completed models. This is most discouraging when you have a number of spectators present who expect to see these wonderful models that they have been hearing about.

Of course, as the skill of the flyers increases, more advanced models can be built, even including scale models and compressed air models. It is interesting to note here that a national contest in 1928 included an event for compressed air models. In 1929 they are going to include an event for compressed air models in the Playground Association National Contest, according to their tentative plans.

The presence of an adult at your meetings will add considerable prestige to your organization, as you can get meeting places, prizes and many other things quite readily with his help, and in addition his suggestions and ability to keep the younger members out of mischief are helpful. This makes the presence of an older member, whoever he may be, almost a necessity.

The dues for your club should be collected at each meeting and charged to those who are not present. Any member who is absent from too many meetings, or who owes dues exceeding a certain amount, which you decide upon, should be automatically dropped from the organization. For taking in new members after the club is first organized there should be an initiation fee which will help to defray the expenses of the meetings, notification cards, and other miscellaneous expenses incurred.

In concluding these remarks about the formation and operation of a model club, it is suggested that you run your club on a conservative basis. Do not try to have too many meetings—one a week is sufficient and twice a month is quite often very satisfactory. Be sure that everything is organized and planned ahead of time so that your meetings and contests will run smoothly.

Get busy right away if you have been contemplating organizing a club and get in on some of the fine, interesting work which model flyers experience. Try to get your members in the world record class and send them to national contests wherever possible; 1929 is going to be a banner year for model aviation, so get started today!

How to Conduct a Model Contest

For indoor contests the largest auditorium available should be obtained. One with a high ceiling is most desirable. An auditorium with a finished ceiling is to be preferred over one having girders on which models may be caught and spoil a contestant's chances. A large floor area free from seats is a considerable advantage, especially in an indoor scale model or commercial model contests, as the models are more liable to be damaged on the corners of the seats. For outdoor contests the largest possible level field should be used. An area free from trees, buildings, streets, ravines and other obstructions is obviously desirable, as modern model planes fly occasionally for remarkable distances. Even rubber-driven model planes have been known to fly close to two miles unofficially, while the world's record in 1929 stood officially at 1½ miles. You will remember that the Jaros world's record model was lost in the air at its highest point after the judges had followed it for this distance. Obstructions as well as producing up currents of air often damage the model or else hide it from view. Models have been lost or broken many times in this way.

A suitable place should be picked for starting the flights. If on a calm day the

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starting point should be out in the center of this unobstructed area. If there is a breeze blowing, the starting point should be to the side or corner of the area from which the breeze is blowing so that the models will fly out over the open space.

If many spectators are expected, they should be requested to stay away from the contestants' area. The contestants' area can be roped off. Quite frequently for city and national meets the aid of the local police can be solicited to keep the spectators back out of the way. Keeping the spectators away from the contestants is very important, as people seldom realize how fragile the models are. They frequently break machines by handling them and have even been known to step on models. Of course, the police should be kept at their posts of keeping the crowd back because the author has recollection of several instances where the police broke a model that might have broken a record. Such an episode occurred at the Atlantic City Playground Contest, when Mr. Rassner's fine hydro model was ruined by an officer who was

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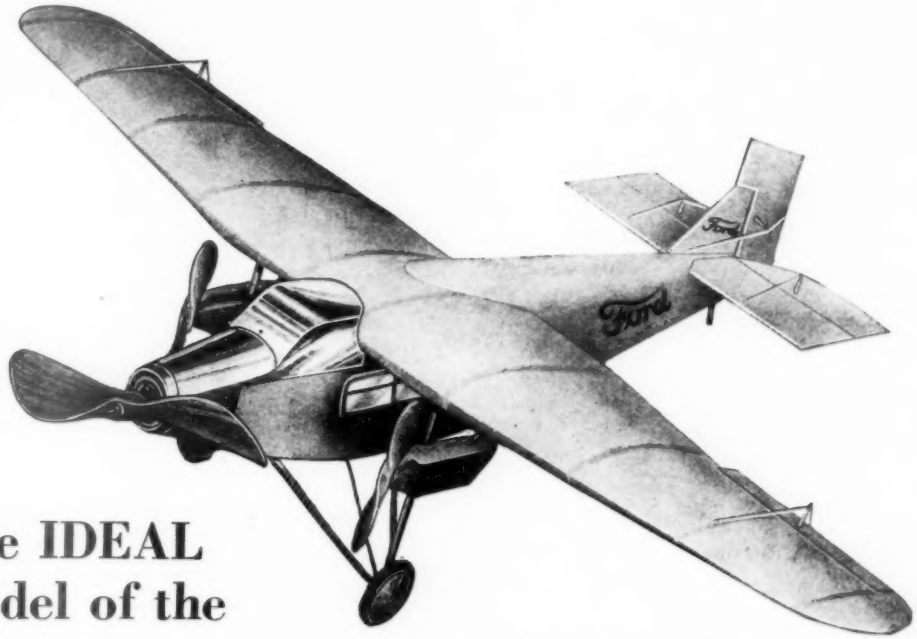

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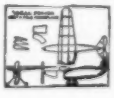

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in the way when he should have been patrolling the spectators' line.

In other words, do everything possible to give the flyers protection. If they are given sufficient room to work in for assembling and laying out their model boxes and other paraphernalia they will not bother each other much, because they understand how fragile models really are.

Each model flyer should be given a space to work in and assemble his models. A fine idea was developed at the Atlantic City Playground Contest in 1928 when they provided a table for each contestant. Because the day was quite windy it was found advisable to lay the tables on their side and use the top of the table as a wind break. Because of the presence of these tables the contestants had little trouble in assembling their models, even though the wind was so high that they had trouble flying them afterwards. Tall grass forms a good wind break for assembling and repairing models at contests.

Because the model flyers must be allowed ample time to wind each model, you will find that a model contest is usually a fairly lengthy proposition. Experience of the old flyers in the Illinois Model Aero Club over years of model flying under all sorts of conditions has finally caused them to conduct one event only at a time in practically all of their contests.

However, some who did not have this wealth of experience have tried to run a large number of events even in one evening. Such a condition occurred at the Memphis and Atlantic City National Model Tournaments of the Playground and Recreation Association. Many of the contestants who were at either of the contests will recall the late hour at which the final events were completed in the wee small hours of the next morning. Even then the judges were forced to use high-pressure methods and literally chase and rush the boys through the events. This same condition occurred at several Detroit National Contests, where even only one event was handled in the evening.

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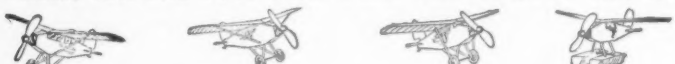

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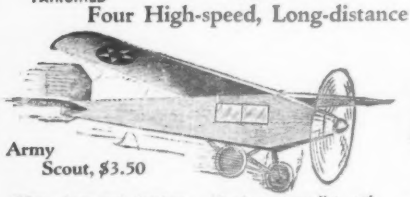

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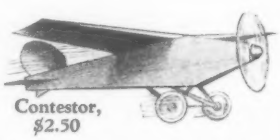

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Either Model Packed in a Box
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Universal Model Kit. The Choice of Every Scout Master

Builds 6 Baby R. O. G. Models or 3 Large Transport or Commercial Monoplane, or Any Indoor Models. 36" Balsa Strips, 1/32, 1/16, 1/8, 3/16, 1/4", 16" pieces bamboo, split bamboo, dope, glue, piano wire, washers, bearings, jap tissue, rubber. Complete kit, $1.00, postage 10c.

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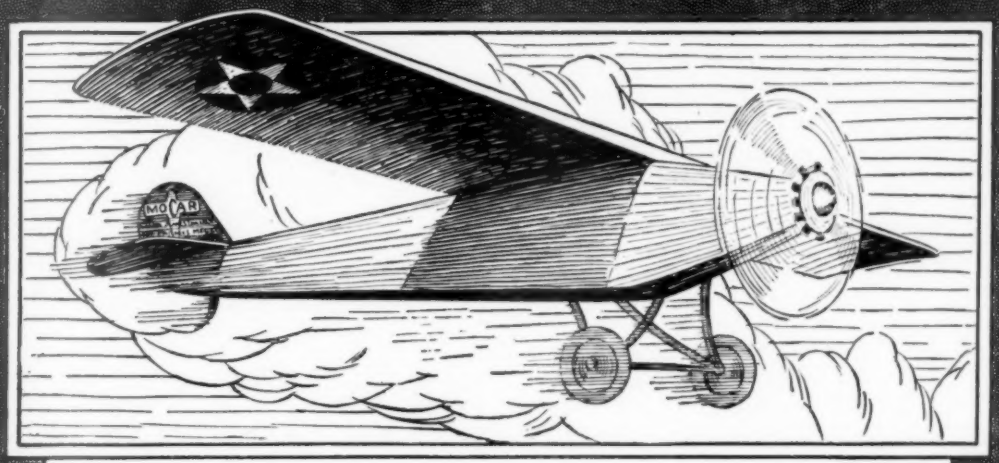

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It is just the kind of plane that the airplane builders like, especially the "Green-Horns."
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Dear Sirs:
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The "Mocar" monoplane—Set No. 1—is a copy of Lindbergh's famous *Spirit of St. Louis*. Wing spread 18 inches, fuselage 12 inches, powerful motor, special ball bearing propeller, rubber tired disc wheels. Weight complete only about 2½ oz. This is a practical, simple, real model plane that gives you a whole lot of fun at a very moderate cost. The all metal construction makes a sturdy plane that will stand a lot of abuse. The outfit is mounted on cardboard with all parts plainly marked and full instructions, for assembly. Pliers only tool necessary. Construction Set No. 1. Complete with rivets, bolts, wheels, wing and fuselage covering material, only $1.50 postpaid (3 for $4.00). Model L made up ready to fly $2.25 (3 for $6.00 postpaid).

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Construction Set No. 1

Only

$1.50

Complete Postpaid

that the flyer can get his model ready for the flight in 2 minutes, you can see that it would take 500 minutes to get just one official flight for each contestant. As all contests should give the flyers 3 official flights, it would take 1,500 minutes, or 25 hours, to run the contest. If the contestants are divided in three groups it would still take about 8½ hours to run the contest with only one event.

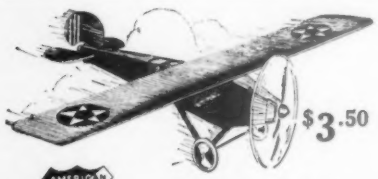
In other words, the committee in charge of the contest should make an estimate of the time required for the contest and then divide the contestants into a sufficiently large number of groups so that the contest will be ended at a reasonable hour. Six groups in the example given above would still make the contest last about 4¼ hours. If there were eight groups the contest would last about 3¼ hours, since some of the groups would take slightly longer than others.

Carefully plan the times in your contest so that you will not leave the contestants with a bad taste in their mouths. Give them all a fair chance and three official flights without being rushed to death and let them get to bed by midnight, at least in an evening event.

Remember that you will lose time at the beginning of a contest because of the necessity for the model flyers to make trial flights. Also you will lose time at the end of the event in making the announcements of the winners and distributing the prizes.

The judges and officials for each group into which you have divided the contestants should be arranged as follows: Each group should have three judges. Each judge should be provided with an accurate split second stop watch for duration events. A man with previous model airplane contest experience or at least with experience in timing events of a similar nature such as athletic contests should be made the head of the group or group leader. Another judge should be the recorder and record the time made by the contestants. A third judge should see to it that the model flyers are warned ahead of time when their turn is to come and to see that the flights are run off steadily and without a hitch.

(To be continued)



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Will fly beautifully and is extremely *durable* . . . good for many hundreds of flights without damage.

Has all-metal motor mount, sturdy wings, scientifically designed aluminum propeller and shock absorber landing gear with rubber-tired wheels.

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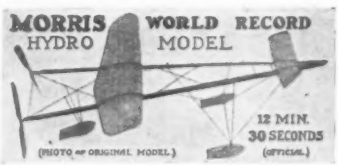

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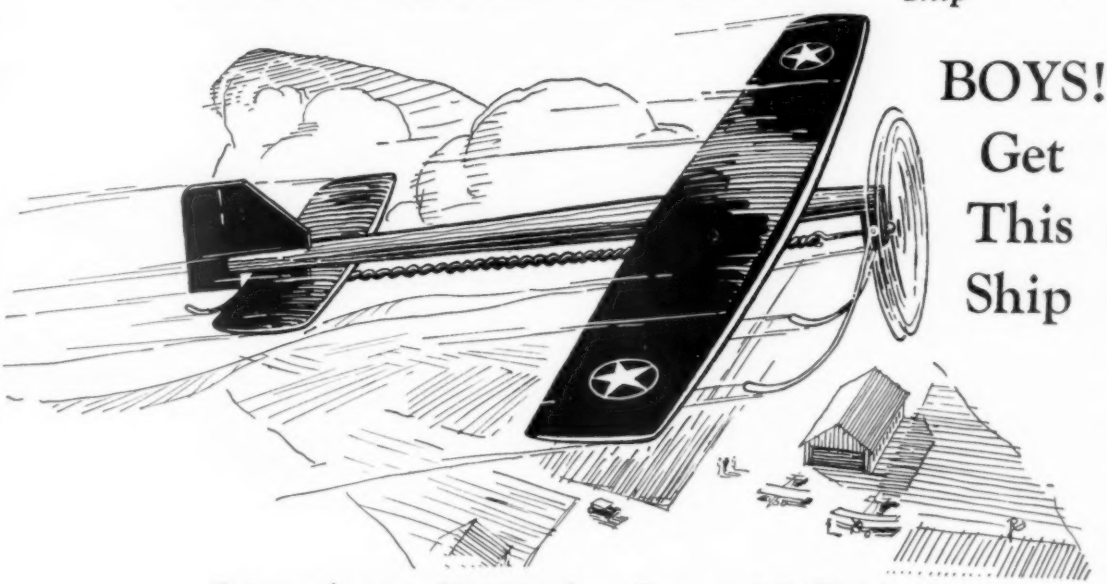

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Rises from Ground—Soars 60 Feet

The development of the Red Ace Combat Pursuit Ship will be nothing short of sensational in the world of model planes. Here's one plane that will not disappoint you—one plane that will perform like a real ship. Has wing spread 16″ with main fuselage stick 14″; reinforced main wing; perfectly balanced tail wing and adjustable rudder. Main wing can be shaped to suit conditions. Has front landing gear and rear skid. The perfectly carved, 7″ wood propeller is a particularly fine feature. Has ball bearings on propeller shaft; 6 ply motor of newly developed extra strong para rubber. This is not a construction set, but a completely assembled plane. Simply fasten wings and launch.

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The Red Ace will rise from ground under its own power. Will climb easily to 60 feet. Will soar over rooftops and buildings. Then, glide perfectly to earth. This large-sized, carefully made plane will outperform many planes costing 5 times more. It is guaranteed to fly. It is guaranteed to rise from ground under own power. This plane will please any boy immensely. A perfect marvel of simplicity and powerful performance. Whether you now own a model plane or not, whether you own 50 model planes, you will want the Red Ace. It will be the prize ship in your hangar. Don't let a day slip by until you order this plane.

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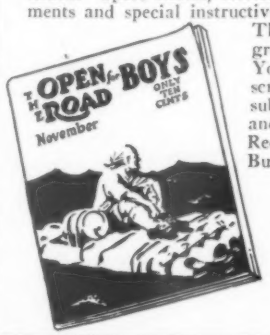

The Open Road for Boys is the fastest-growing boys' magazine in America. You'll think it is great! Regular subscription price $1 a year. Rush us your subscription today on coupon below and we will give you free the Red Ace Combat Pursuit Ship. But you must act at once.

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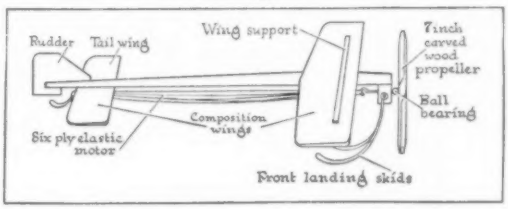

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A further announcement of the plan is made on another page of this issue.

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1/16"x1/4"x3'	.054	.06
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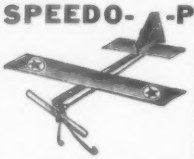

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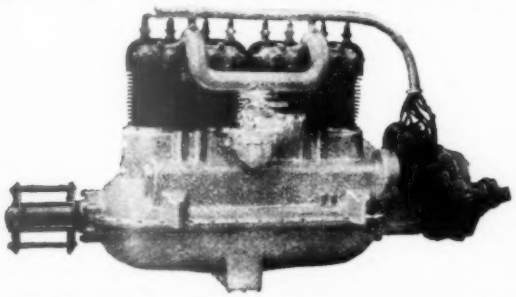

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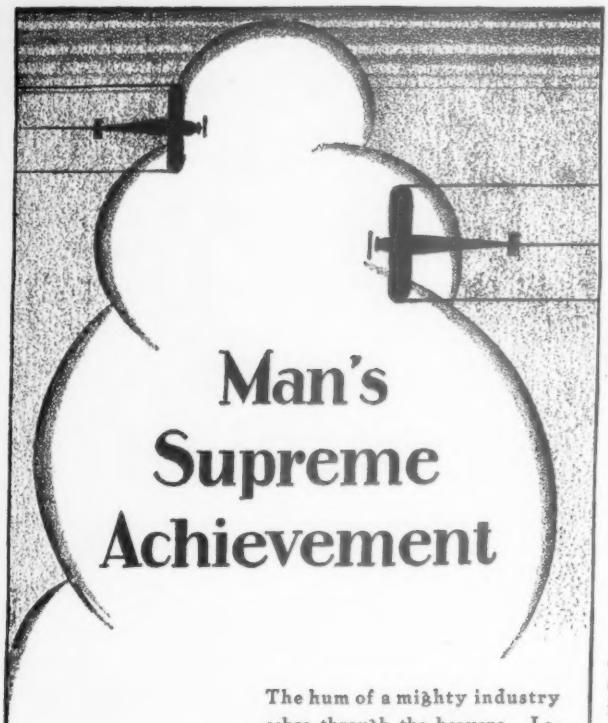

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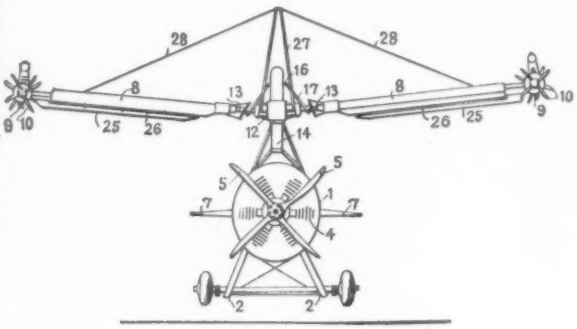
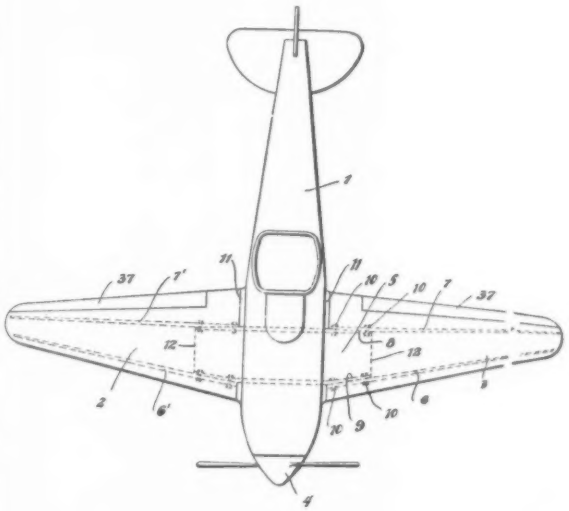
Patent Department

No. 1,697,009, Flying Machine, Patented January 1, 1929, by Vittorio Isacco, of Paris, France.



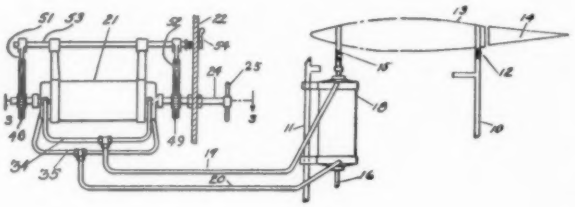
A machine of the gyro type of aircraft, very similar in design to that invented by the well-known Spaniard, Juan de La Cierva, but which is characterized by the mounting of individual engines at the tips of the blades of the horizontal propeller, which permits of reducing considerably the power necessary for operation.

No. 1,697,151, Aerofoil or Wing Construction for Aircraft, Patented January 1, 1929, by Arthur L. Thurston, of Hammondsport, New York, Assignor to Charles H. Keel, Trustee, of New York, New York.



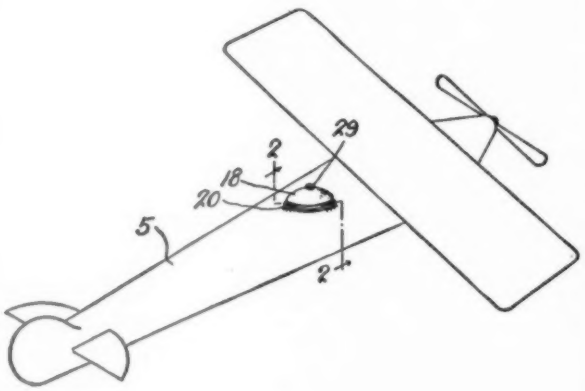
The object of the invention generally is a wing possessing novel features of construction which enable it to be designed with more scientific and mathematical accuracy and whereby the proportions of the various parts thereof may be chosen and arranged with reference to each other to give a substantially uniform factor of safety throughout. Such a wing may with certainty be designed with the required factor of safety without unnecessary weight and useless load.

No. 1,698,853, AIRPLANE, Patented January 15, 1929, by Charles K. Morton, of Cleveland, Ohio, Assignor to The Glenn L. Martin Company, of Cleveland, Ohio, a Corporation of Ohio.



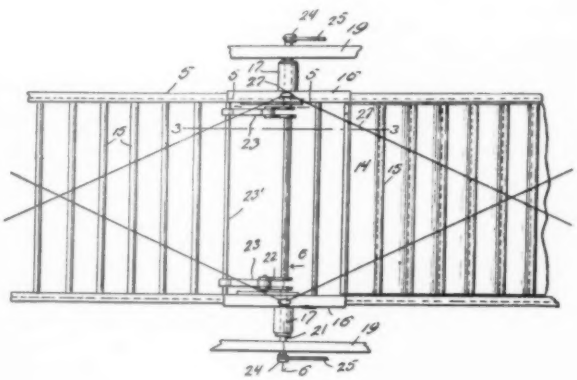
This invention relates to improvements in airplanes, but has reference particularly to means for adjusting the horizontal stabilizer or any other part of considerable size which it may be desirable to adjust.

No. 1,699,156, MAIL RECEPTACLE, Patented January 15, 1929, by Frantz Nielson, of Afton, Wyoming.



A buoyant receptacle for mail, designed to prevent the loss of the mail from airplanes used in trans-ocean service.

No. 1,699,699, AEROPLANE PROPELLER, Patented January 22, 1929, by Frank W. Jatunn, of Troy, Montana.



A propeller structure, designed particularly to effect a lifting action, having two series of collapsible vanes, with means for collapsing one series of vanes and simultaneously spreading the other series of vanes.

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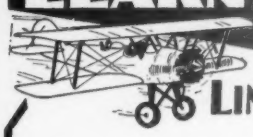

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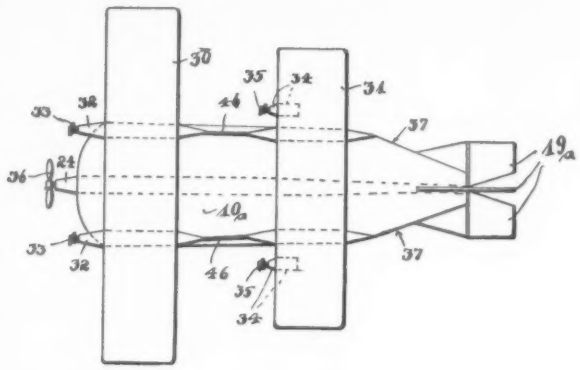
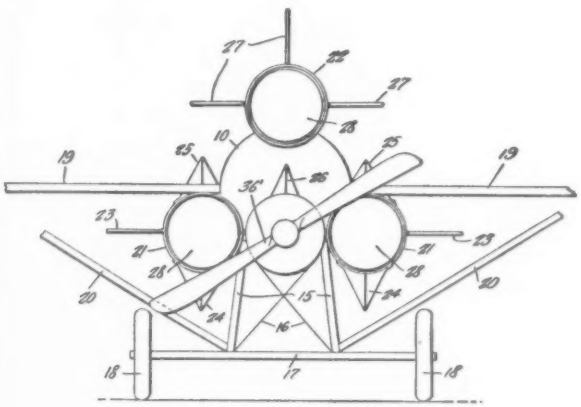
No. 1,697,626, FLYING MACHINE, Patented January 1, 1929, by Peter Arndt, of Los Angeles, California.



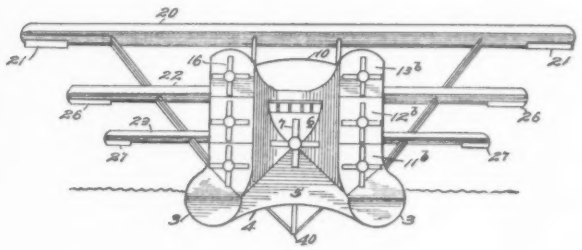
This patent is what might be termed a train of airfoils, having longitudinally and transversely disposed planes, a fuselage disposed between the planes and connecting the same and embodying cabins adapted to be reached from the top surface of the longitudinally disposed plane.

No. 1,698,626, FLYING MACHINE, Patented January 8, 1929, by Solomon Charles Gins, of Charleroi, Pennsylvania.



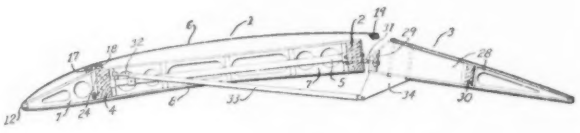
The inventor in this case is endeavoring to provide a novel soaring and gliding means which he claims will permit of a safe landing in the event of mishap or trouble with the motor.

No. 1,700,290, ECHELON PLANE AIRSHIP, Patented January 29, 1929, by Augustus J. Harpstrite, of Los Angeles, California.



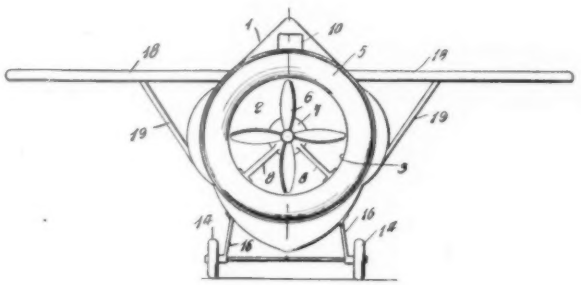
An object is to provide a heavier-than-air vessel combining a gas cell body and a system of supporting or flying planes; the purpose of the use of gas being to lighten the load and render the landing of the ship of greater ease in vessels of the larger size, such as this invention concerns.

No. 1,697,674, AIRPLANE WING, Patented January 1, 1929, by Paul G. Zimmermann, of Keyport, New Jersey, Assignor of one-fourth to Joseph F. Brandenburg, of New York, New York.



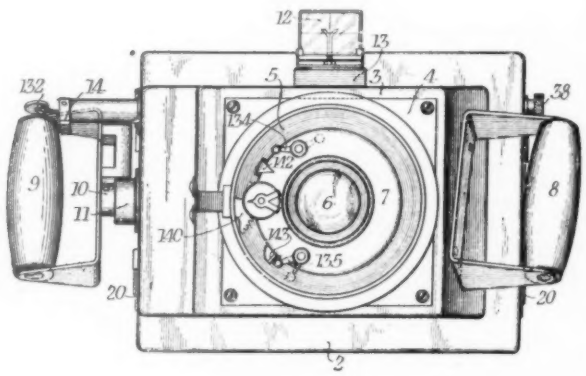
The subject of this invention is a wing which can be changed in flight from a high-lift to a high-speed wing and vice versa, by breaking the upper side of the wing at a given point or points, thus varying the thickness of the wing while preserving the curvature of the upper side in front and in rear of the break.

No. 1,697,770, AIRCRAFT, Patented January 1, 1929, by Wilhelm Kreikenbohm, of Detroit, Michigan.



The invention relates to aircraft or flying machines of the heavier than air type, and provided with sustaining wings, and has for its principal object the provision of an airplane having its body provided with a longitudinal passage therethrough, in the front end of which is mounted a propeller and a motor for driving the propeller, the air driven rearwardly by the propeller through the passage assisting in sustaining the airship.

No. 1,698,063, AVIATION CAMERA SHUTTER OPERATING MECHANISM, Patented January 8, 1929, by George H. Ohlau, of Rochester, New York, Assignor to Eastman Kodak Company, of Rochester, New York, a Corporation of New York.



An object of this invention is to provide a camera in which a series of exposures may be made rapidly, and inventor has provided gripping handles for holding the camera and controlling the exposures, so that the camera may be operated without releasing the handles.

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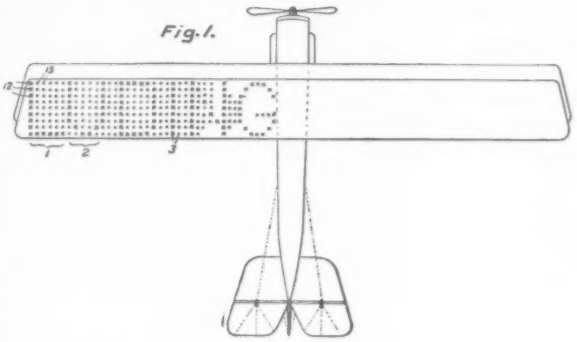
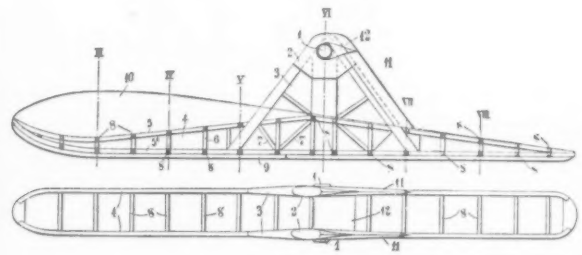
No. 1,698,721, AIRPLANE FOR NIGHT ADVERTISING, Patented January 15, 1929, by George Hand, of Laurel Springs, New Jersey.



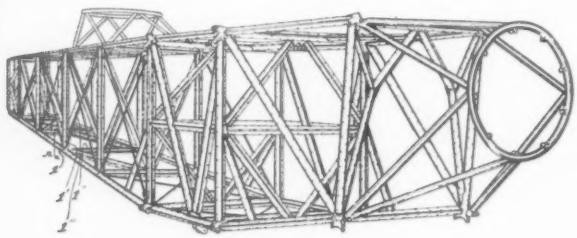
The principal object of the present invention is to provide an airplane for night advertising which shall be possessed of an outer wing curve and which shall be devoid of parasite or added resistance such as would be produced by lamps or other parts projecting beyond the wing covering and which affords convenient means for changing letters or other display while in the air.

No. 1,698,808, SNOW LANDING GEAR FOR AEROPLANES, Patented January 15, 1929, by Michael Adamtchik and Giuseppe Massera, of Hampstead, London, England.



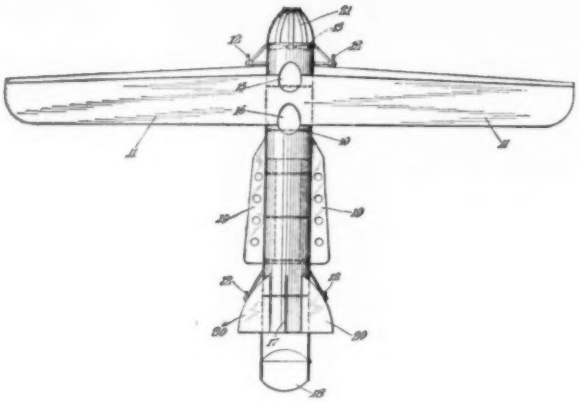
The invention consists in strengthening the tread of the ski and its attachment to the axle journal of the aeroplane by means of a system of trusses whereby a maximum of strength is attained with a minimum of weight.

No. 1,698,849, AIRPLANE, Patented January 15, 1929, by Clifford J. Leisy, of Cleveland, Ohio, Assignor to The Glenn L. Martin Company, of Cleveland, Ohio, a Corporation of Ohio.



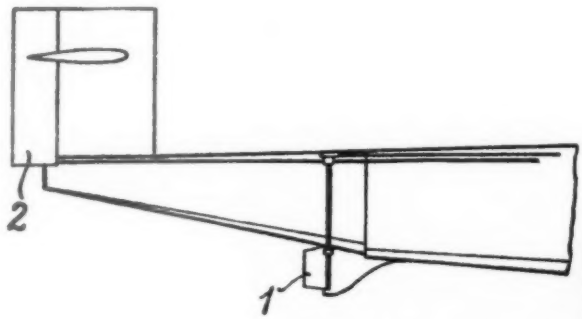
Structural members for the framing of airplanes and joints between such members are provided in this patent in such a manner as to facilitate the inspection and treatment of the internal surfaces of built-up metal structural members for use in airplanes.

No. 1,699,986, AIRPLANE, Patented January 22, 1929, by Oscar Palmer, of New York, New York.



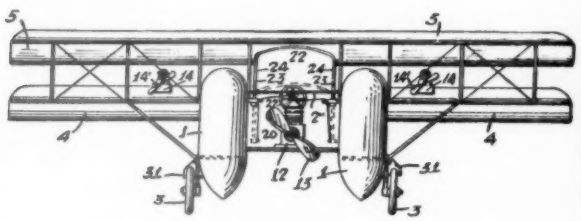
According to this invention the fuselage of the airplane comprises a tubular longitudinal member to which are attached wings. The propeller is mounted within the tubular member adjacent its forward end so that the air pushed backwardly by the propeller passes through the tubular member.

No. 1,699,991, HYDROAEROPLANE, Patented January 22, 1929, by Adolf Rohrbach, of Berlin-Wilmersdorf, Germany.



A hydroplane provided with separately arranged air rudder and water rudder, the particular arrangement permitting the pilot to either control the water rudder together with the lateral control air rudder surfaces or leave it at rest and separate it therefrom.

No. 1,700,107, FLYING MACHINE OF THE AEROPLANE TYPE, Patented January 22, 1929, by Max B. Pupp, of Souderton, Pennsylvania, Assignor of one-half to C. K. Gotwals, of Souderton, Pennsylvania.



A construction providing two tubular cabins, the upper portions of which provide buoyancy gas compartments, and the space between the two compartments having arranged therein a flexible folding air dome and means for raising this air dome when used for buoyancy purposes or to be lowered into a folding position when the machine is traveling through the air.

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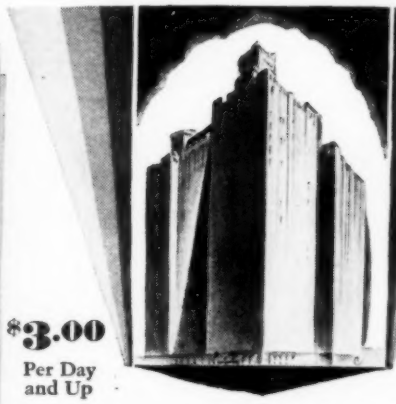

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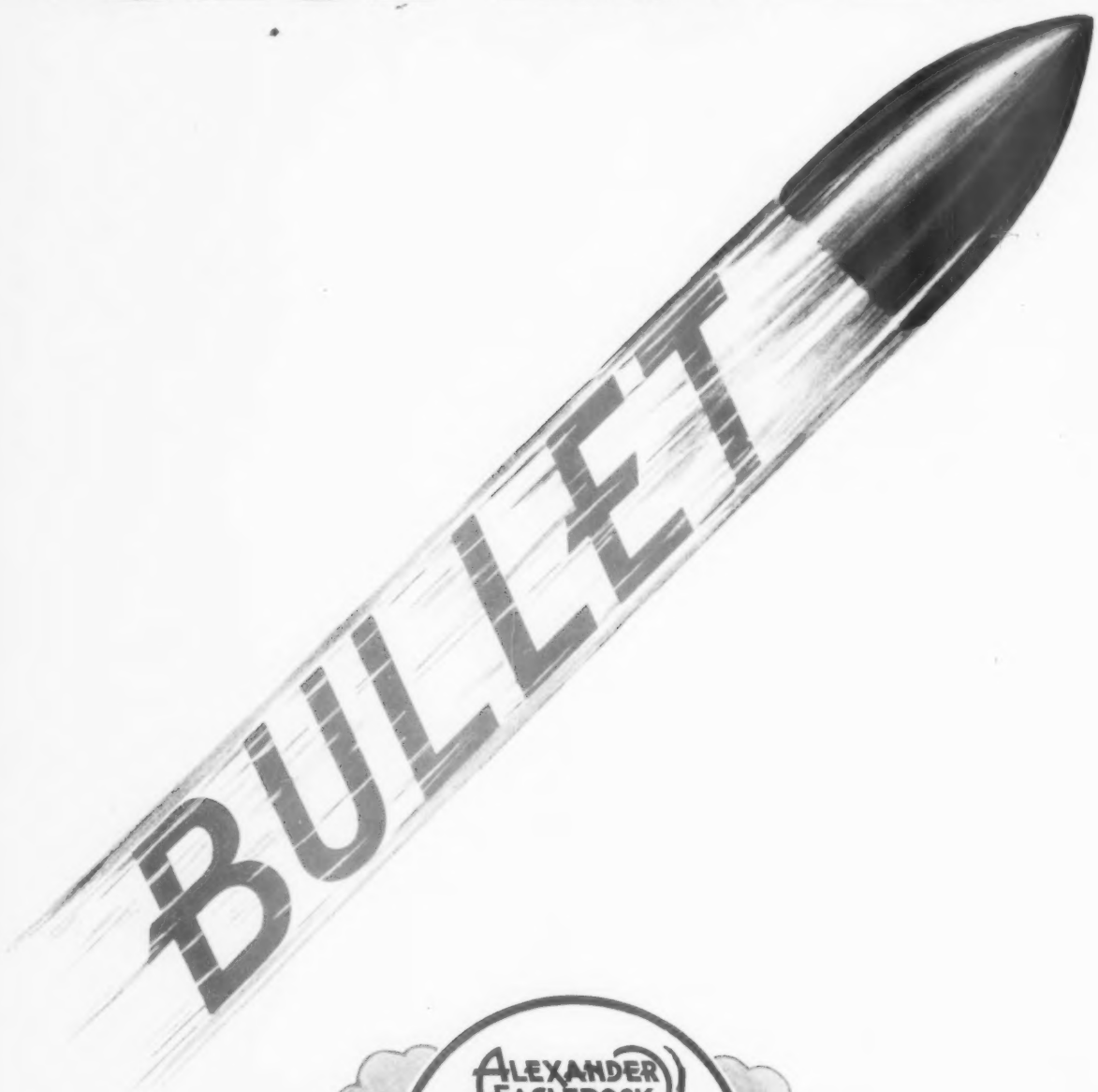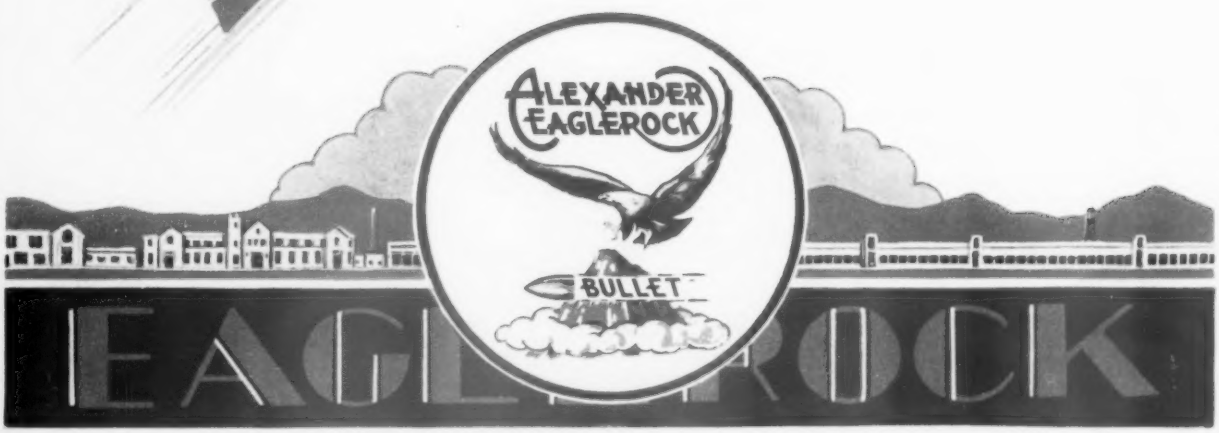
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